Thomas Hope 1766 – 1844. Prof chem Edinbor

1795 – 1842. . Son of the Prof. of Botany, John

~~22 Macleod d. 1922~~

21. ~~Coupland Ed. M. S. 1905~~

4581B. ~~Dawson " 1924.~~

12. ~~Geikie, 1923.~~ ~~1835 – 10. Nov. 1924.~~

75-75

notes about the handwritings

re-insert loose

~~Dawson, n. s. vol. 31, pp. 1-21,~~
~~p. 5. Art 5 ve effort A2~~

McKendrick. J. G. d. 1926.

Fowler. IV book 2. 24.

7575 vol. 1.

~~vol.~~ 1. Inserted notes handwriting resembling writers W+
not " " W-
resembling Desmoulins D+
" " " D-

p 9^bc W+
39^b W- D-
93^bc. W+
111^b D+ cf. med. in last line.
120^b W+
135^c (W+?) D+
138^b compare the H of L'heure & the J of jeune here (which is a later + Desmoulins?– note) with the h of melancholie, p. 147^b, & the j + jamais, 147^a, both in the original hand. Also the side notes on p. 176 are in the later hand.

The corrections in the text are in the hands of the inserts.

The g & J (cap. & sm. H.) of both are similar (e.g. 147^b)

P.T.O

→ length of them (perhaps cut this margin)

width

R. H. Braun

Taken during a Course of
[illegible] University

La Houssaie mem. hist. quoted at p. (ii) 43b

Hist. d. p. des env. de par " " 27b (8 pensions)

Forestus " " pl. " " " 55b.

Compare med. & chir. of hist. par. ii (1st) p 198
with Desmault's mem.

Thomas Hope 1766–1844. Prof chem Edinbro
1793–1842. Son of the Prof. of Botany, John
Hope (1725–1786). Both were great friends
to american & colonial students in Edinbro
The collection of Theses by colonial students
in Edinbro, which I bought in 1902(?) from
G.S. Johnston & gave the Library of the
Medical & chirurgical faculty, Baltimore
came from the Hope family & many of
them are specially bound presentation
copies (see list & account in No)

Thomas Hope was a student of Lavoisier
and joint professor of chemistry with
Black. He was a very popular teacher
He published very little but his copies
of his lectures are not uncommon.

The Mr Tolley for whom these were
transcribed was probably the well known
St Thomas' Hospital Surgeon. whose son
Edward Tolley was a good friend of mine
practised for many years at Colorado
Springs & did good work in Tuberculosis

W.O.

Btr. Jan/1917

HOPE (THOMAS CHARLES) 1766–1844.

7575. In English, on paper: written between 1801 and 1848: $8\frac{3}{4} \times 5\frac{1}{2}$ in., x + 780 and ix + 769 pages.

Lectures on Chemistry by Thomas Charles Hope, University of Edinburgh, 1801, with a few figures. In 2 vols. Probably transcribed at a much later date by R. H. Brabant, whose name occurs at the beginning of each vol., and who graduated M.D. in 1821 (no. 5843, p. 64); presented to 'Mr. Solly' by the transcriber in 1848. Written on one side of the paper.

Bought in Jan. 1917.

T. C. Hope, professor of chemistry at Edinburgh from 1795 to 1842, was the son of the professor of botany, John Hope (1725–86). Both were good friends to American and colonial students. The collection of theses by American students in Edinburgh, which I bought in 1902, came from the Hope family, and many of them are specially bound presentation copies (see note to no. 2278).

Hope was a student of Lavoisier and joint professor of chemistry with Black from 1795 to 1799. He was a very popular teacher. He published very little, but MS. copies of his lectures are not uncommon.

Mr. Solly, the former owner, was probably Samuel (1805–71), the well-known St. Thomas's Hospital surgeon, whose son Edward Solly (a good friend of mine) practised for many years at Colorado Springs and did good work in tuberculosis.

W. O.

To

Mrs Polly

with the friendly regards

& best wishes of

the Transcriber

1840

x (alto.)

Chemistry

Dr Hope -

-1801-

Lecture 1st

Chemistry investigates the actions which take place between the minute particles of bodies when they are brought into circumstances favoring such actions of which this is a characteristic acquisith that a change is produced in the Natures & properties of the substances employed Chemistry investigates the change thus produced and the properties newly acquired and it endeavors by induction to find the Cause of these Phenomena & the law of Nature to wch wch this change may be referred

In the prosecution of this Course I shall first endeavor to explain the general principles of Chemistry and then proceed to a more minute detail of its Phenomena and the uses to wch they may be applied and thus the

school of the Course I shall take every opportunity of illustrating chemical Pharmacy by examining the processes directed in the Pharm: L & E. exhibiting as many of them as can be done with propriety in your presence and pointing the respective superiority of the process directed by either College.

In explaining the general principles of Chemistry it appears to me advisable to give you first some account of the nature and properties of heat that you may the better understand what is to follow.

Heat in common language has a double meaning signifying that sensation which we feel on approaching the fire — on being exposed to the rays of the sun or agitated by violent exercise It also means the principle or Quality which excites this sensation and accurately requires that them should be distinguished and accordingly with the French Philosophers we denominate the Cause Calorie, the effect Heat

The properties of Caloric are that it is exquisitely subtle elastic fluid, void of gravity repulsive of its own particles and attractive of the particles of other bodies — Caloric is excited by Percussion Collision and Friction — Thus Blacksmiths sometimes elicit fire by striking a Bar of Iron till it is red hot & then immersing into the middle of the fuel — and Thus the particles of steel struck off instantaneously by a flint in the lock of a musket are ignited and kindled to a bright heat by the air for the sparks are much less vivid in vacuo than the friction of Carriage wheels if they are ill greased sometimes obtain fire & Thus by friction the inhabitants of the Southsea Islands kindle their fires at pleasure — Some experiments made by Count Rumford on the unbounded quantities of Heat excited by friction have induced him & others to believe that it is a mere quality or modification in bodies, whose essence consists in the motion of its parts — The properties of caloric are applicable to other bodies are expansion fluidity Vapour & Ignition

I now come to speak first of the expansive property of heat or caloric. The particles of caloric are supposed to be repulsive of each other and to this chiefly it is owing that there is a constant tendency to an equilibr. of temperature in the bodies in relation to each other. To this effect may be ascribed in part the attraction which the particles of caloric bear for other bodies and this tendency to restore equilibrium of temperature is equally manifest when the substance heated to any degree is suspended in vacuo which is said to be a corresponding proof of the materiality of caloric as there is no substance to convey it which would be necessary to this effect were it according to the mechanical theory merely a quality or modification of bodies depending on a motion of their particles — without entering into a discussion of this intricate question at present it may be proper just to remark that whether a real substance or a modification is intended the term caloric seems equally appropriate

as Darkness is a privation of Light

Tho we are better acquainted with this subject and have more unquestionable data on wch to proceed it seems rash to attempt trains of Hypothetically deduct^n. wch some have ventured and particul^y to suppose that caloric is a compound body consisting of light united to an unknown base

Cold is a denomination abstractive or privative of heat. & and may be distinguish^d like heat into cause and effect — Some have supposed that Cold was a positive quality or substance and have referred to sensation as a proof but give me leave to take this opportunity of remarking that sensation is a very fallacious test as any one may prove to himself by immersing both hands into water of a medium temperature after one has been subjected to the effect of a freezing mixture — the other to that of a boiling heat —

— The expansive power of heat I shall illustrate by an experiment on Iron on Alcohol and on common air all of wch you have seen in every dimension &c

when heated and are again reduced to their former bulk as soon as the heat is abstracted.

From this expansion a very important inference has been drawn in natural Philosophy and it now generally admitted that the particles of bodies are not in actual contact for then they could not contract into a closer space, but that they are all immersed in the matter of heat and that they approach or recede from each other in proportion to the increase of temp: & that this is equally true with regard to the most solid bodies

The power which caloric manifests of overcoming the attraction of cohesion is attributed to the repulsion between its component particles and this power is esteemed very great. This expansive property of caloric is much greater in some bodies than in others nor is this in exact proportion to their density — mercury Water &c yielded to their alteration in by fire

This property of fire is applied to many useful purposes thus a Cooper in shrinking

fitted on a wheel, & the hoop in ties and
a cooper does the same on a Barrel wh.
the hoop is red hot. Then on dashing cold
water upon it its circumference becomes
of shorter diameter and it embraces the
cast iron wheel most firmly
It has also many disadvantages, which
were felt especially by clock makers as
the pendulum being made of Iron became
longer in the summer than in winter
and conseq. the clock did not go so fast
But this inconvenience on the very
same principles which occasion it —
for as Zinc is found to be increased in bulk
in a proportion double to the expansion of
Iron or rather more a bar of Zinc is interposed between two bars of Iron connected
the [illegible] of the first with the under top of
the third bar and by this invention this
inconvenience is totally prevented
in — There are however exceptions to this
expansive power of Zinc — The shrinking
of animal and vegetable substances &c &c
very thing into the composition of which
Clay enters as a constituent — but these

there are unfair exceptions as there is a
loss of Substance in some of them a permanent
change of Structure which continues the same
after the reduction of Temperature
erature 32°

To the expansive power of Caloric there is
one remarkable exception. If common wa-
ter or any aqueous fluid be taken at 32 and
additional Quantity of Caloric be thrown into
it it is diminished in bulk to 40° and then
begins & regularly continues to expand
so if it be taken at 50° and regularly cooled
it diminishes in Bulk to 40° then expands
to 32°. This fact was known a century ago
but what the mechanism of the effect of
Caloric in this Instance is no one presumes
to conjecture nor has any one ascertained
the object of this expansion, Count Rum-
ford has endeavored to prove by a numbe
of most ingenious arguments that this
exception and very useful purpose in
the economy of universe but of this
I shall speak particularly hereafter
This expansion however from 40 to 32° is
not half so unusual as we take place at

the moment of congelation — The learned of Sc might have suggested this idea but M. Boyle was the first who remarked it from his experiments he concludes that water expands 1/15 in congelation — The Florentine academicians estimate it at 1/8 — Later Philosophers 1/10 — To determine the degree of force exerted by water in congelation a cubic inch of water was inclosed in a brass ball of an inch thickness and it was gradually turned thinner till the cubic inch in act of congelation burst the ball — from this exp: made by the Florent: acad: it has been calculated that the force exerted in this instance by one cubic inch of water in congelation was equal to raising the weight of 27.720 lbs — It was supposed that this remarkable expansive force arose from the quantity of air extricated in the pores of water into ice — but the cause by no means adequate to the effect and the expansion is equally great if the water be deprived of its air by boiling — The real cause in the new arrangement the particles assume in entering from a fluid

to a solid state by the cohesion of attraction,
the particles observe a sort of polarity in
the formation of the Crystals, There may be
seen to shoot from the side of the crystal some
with it an angle of about 60 degrees and from
this Crystal others will shoot under the same
angle of 60, Flakes of snow consist of a con-
gries of stars of six rays each - the spicula
diverging from each other by an angle of 60
This expansive power in congelation has great effects
in the economy of nature - It cracks the
most towering rocks and [illegible] it shatters
Pillars of Antiquity it hastens the ruin
of all antient buildings and it also greatly
contributes to break the clods for the husband
man thereby increasing beyond computation
the fertility of the soil

This property of expansion in passing from
a [illegible] fluid to a solid state is possessed
by some metallic bodies as Bismuth
Bismuth on the same principles viz a
new arrangement of their parts
As alone is not possessed of any sensible
at least so as to be detected by our balances
it will readily occur that when bodies are

thus expanded by the injection of calorie they are not at all increased in wt but their density and of course their specific gravity is diminished. Therefore when the specific gravity of any substance is stated it is necessary to specify its temperature and the temp. Chemists have chosen for all exp: of this sort is 60°.

The changes wch take place in bodies at different Temp have been employed for the construction of the Thermometer and Pyrometer By these it is that we have acquired all our knowledge of the distribution of heat and its various degrees of intensity in different bodies — The Thermo was first invented by Sanctorio about the beginning of the 17th Cent — The Agents now in the construct: of a Therm: are that the varia: arise only from changes in the Temperat, that these may be readily observed — and the instrument easily appli. Fluids are most usually employed as Air Alkohol Mercury — Air is the most sensible and therefore an Air Therm preferable in some short & delicate exp:

But the Air Thermometer has one great disadvantage that it acts in part as a Barometer

Lecture 4

In constructing a Thermometer it is first requisite to be provided with a glass tube and it is of importance that in every part of it the bore of the tube should be of equal diameter This point may be ascertained by measuring the distance of the span of a small quantity of Quicksilver occupies in any one part of the tube and examining if it occupies the same distance of span in every part of the tube — explanation of the mode in which glass makers form their tubes, viz by blowing a short cylinder of a large bore and thick sides and then drawing it out to any extending according to the required fineness of the bore — To form the bulb the end of this tube is softened and air thrown in from the opposite end by a Caoutchouc bottle — This tube is now to be filled with the intended fluid for this purpose the bulb being heated & extremity of tube is immersed in a fluid & a quantity of this ascends in the tube, this must be heated in the bulb till it begins to ascend in

Vapour which will expel all the air of the atmos-
-phere. If the tube is then suddenly to be
again immersed in the fluid and if it does not
exceed 28 Inches in length it will be immediately
filled by the pressure of the atmosphere / for the
Pressure of the air is not greater than a Column of
Quicksilver of abt 30 Inches — but if the fluid be
alkohol it will rise much higher / Should the
tube be imperfectly filled this last process must
be repeated — The Makers of Thermometers
hermetically seal the top of the tube by means of a
blow pipe if the fluid be mercury — which it is
perfectly filled and on the Ejection of the Pump
necessary for this purpose the Quicksilver
subsides so that there is a vacuum formed a-
bove the Quicksilver — but alkohol will not
admit of this process and therefore in all Thermo-
-meters with this fluid the atmosph. Air is in
contact with the alkohol

Quicksilver was recommended by Haley in
preference to alkohol almost a century ago
and it is for the purpose intended superior
in almost every respect — It has a great

attraction for Heat, it will bear a Temp. of 600°
whereas alkohol will bear no more y^n 180
but a still greater advantage of Quicksilver is
that its expansion in proport. to the Quantity
of caloric required is more uniform

Philosophers took it for granted that an equal
mean of caloric wd cause an equal expan-
sion at every temperature and indeed it was
not very easy to disprove what they had assumed
in this particular — W. Black took 4 ij of
Iced water & two Pounds of boiling water &
mixing them included that in a mixture wch
had a mid^e Temper: equally distant from y^e
points of freezing & boiling — Then immer-
sing the Thermometer in ice cold water he marked
the distance of alkohol rose in immers: it in the
mixture of mid: Temp: & examind if it rose by
an equal distance on changing it from the mid^e
to the boiling heat — he concluded from his
expers: that it did not. This was a very delicate
experiment & subject to some degree of Error —
Dr Crawford taking a tube of white Iron exposed
one extremity of it to the Steam of boiling water
ye other end he immersed in Ice the Therm:
being applied to the Ice ye middle of the tube &

the boiling Steam proved the irregularity of the expansion of alkohol more decisively than it expan.d of Black — But Mercury is found much less irregular in this respect

Still an alkohol Thermometer is of use in exploring the temp.e of any substance below Mercu.y 40. or 72 degrees below the freezing point as Mer.y freezes at that temp.e

To complete the Thermometer it was requis.e to add a scale wh. might indicate its variations with precision — For this purpose some fixed Point or points were necessary by which this Scale might in all instances be regulated without vari.n Such is that point at which Water begins to freeze or more accurately that at wh. snow melts — and the Heat of boiling water in another point but not quite so steady for that water usually called hard boils at a somewhat higher temp.e than distilled water — & the pressure of the atmosphere wh. is ab.t 15lb. ℔ on every Sq.r Inch being freq.y varied will also creat a correspond.g vari.n in the temp.e at wh. water boils, so that the heat of Steam freely expelled is preferred as a Standard — For in this County the range of the barometer is three Inches

According to experiment it appears that a variation of not less than three and a half or four degrees in the heat of boiling water will take place within the extreme points of this range but the heat of Steam is uniform

It was now necessary in order that all Chemists might speak the same language to ascertain some determined points in the Scale to these Standards of Temp — And every Country has had some noted Philosopher whose example they followed in this Particular — In England we adopt the Scale of the Dutch Philosopher Farenheit He chose to divide the Variation of Temp between the heat of boiling Steam and that of melting Snow into 180 degrees and supposing that the greatest degree of Cold was produced by a mixture of Salt and Snow he called this Zero making it the beginning of his Series or 0. he found that the freezing Point was exactly 32 of his divisions higher on the Scale — and this added to 180° made the point of boiling water or Steam 212° But soon after discovery that much greater degrees of cold could be produced than that by a mixture of Snow & Salt He made our

inverse series from 0 which is distinguished by the addition of minus — Thus Quicksilver is said to freeze at 40 minus or 72 degrees below the point at which water freezes

The Scale adopted in France is that of Reaumur who divides the Space between boiling Steam and the freezing Point into 80 degrees & makes the freezing Point Zero. — To make the Language of Reaumur the same with that of Farenheit multiply by 9 divide by 4 & add 32 & vice versa to change that of Farenheit into that of Reaumur

80 Reaumur
9
4 | 720 | 180
32
212 Farenheit

In Sweden the Scale of Celsius is made use of he divides the distance between freezing & boiling into 100. degrees to convert his language into that of Farenheit multiply by 5 divide by 9 & add 32 to the product this is called the Centesimal Thermometer it is much used in France and may probably one day be adopted in England (Fourcroy in his Chemistry has sometimes used the Scale of Celsius & at others that of Reaumur without informing his reader that he did so which may lead into Error) To avoid the trouble of converting the Langs

of one Thermometer into that of a different scale a Table may be formed for reference similar to that in Lavoisier in which the correspond^g degrees of different Scales are placed opposite to each other

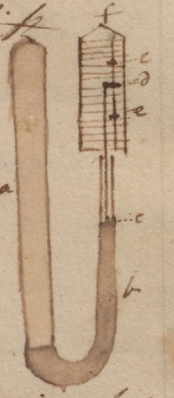
In making experiments the bulb of a Thermometer should be small as the calorific fluid will move readily and a bulb of a pear shape with the point downwards is less liable to be broken than one of a round shape —

In experiments where the Temperature is below minus forty a Therm: of the purest alcohol should be employed —

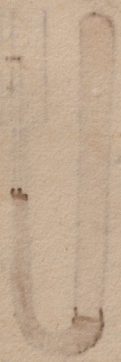
and whenever great nicety is required the bulb of a Therm: should be blackened as the light has a considerable effect upon it for if two Thermometers one with a bulb blackened — and the other in a State of Glass unblacked be perfectly in unison with each other at Sunrise the unblacked bulb will be in a degree higher than the blackened one at noon

The Thermometer is now arrived at a state of tolerable degree of Perfection so far as its range extends — Its great utility is felt by all rational Brewers Distillers Dyers Vinegar makers

by every practical Chemist and every expert Philosopher — Tho' however many were desirous of knowing a Therm: wch would indicate its greatest variations its highest or lowest Temp: in places inaccessible or when the person wanting this Instrument was absent. so that he might be under the necessity of watching — To answr this purpose a float of silver wch will rise on the surface of the mercury and remain Stationy in the tube when the mercury shd subside — or wch will descend with the merc: & remain equally fixed while the mercury rose there a groove in the side or middle of the float — Sir Jas Lowendish & Mr Sutherland have contrived a single Inst with two tubes for answering both these purposes — but the most simple is that of Mr Kirk of which this is a rude resemblance



a is intended to represent the largest part of the tube filled with colord Alcohol b the smaller part filled with quicksilver c a float connected by an iron wire to d. which is an index moving on a thin piece of wire on which wire are placed two small bits of coloured Silk e. e which move easily & consequently when at rest there two are applied to the index d



these bits of gold silk shew the greatest ascent
or descent of the Thermr before the morning
or next time of exam:

It has been proposed to affix to the pencil
and to annex a cylinder wch might revolve
by clockwork
once a week in such a manner as that the
pencil might mark on the cylinder all the
variat: of the Thermr during the week

To ascertain the Temp in some manner
Strat: or Bish Caverns a non conducting
substance such as wool is wrapt round the
Thermometer, it is let down into the Cave
and after remaining a sufficient time is
suddenly withdrawn

This however as glass, will not bear a red heat
Chemists and Philosophers were greatly at a loss
to determine the higher degrees of Temp — The
only com criteria were exceedingly vague —
a dull red heat a bright red heat — a dull
white heat a bright white heat —

The elongation of metallic rods was em-
ployed — but this was very imperfect way
of determining — It was very uncertain if
their elongn was in proportn to the increase of
heat

Sir Isaac Newtons mode was the first that was tried and it was not found practically applicable to any useful purpose but deserves to be mentioned — He exposed a rod of the substance he wished to examine to the Air: but it was sufficiently cool to admit the application of the Thermometer — he then examined the velocity with wch it cooled & formed his estimate of its previous heat accordingly

Another mode is to mix a hot body with a cold one — thus a hot Iron is plunged into cold water — and the Temp.e of the Iron is estim.d from the Quant.y of Caloric imparted to the water but this is liable to great inaccuracy Mons.r Lavoisier and La Place invented what is called a Calorimeter in which the body to be examined is melted in Ice & its heat est.d by the quantity of Ice melted.

Thus the heated body is placed in a middle compartment of Ice surrounded with Pounded Ice on every side — & excluded from y.e Cont.t of the atmosphere by an external compartment filled with Ice — The melted water is received in a vessel placed below for that purpose — But it was objected that part of the water

so deposited is to be imbibed between the pores or interstices of the powder &c & thereby the result fallacious — to obviate this the vessel filled with powder &c is kept in a warm Temp.re till the melted Ice has filled the Interstices — Still I think the results will not be quite accurate as the water filling the Interstices will be partly mixed with the mercury together with the water of melted Ice — But the Cilinmeter is a useful Instrum.t and many interesting experim.ts have been made with it

The late very ingenious Mr. Wedgewood from a want of some Instrum.t to measure high degrees of heat in his Laboratory was led to employ clay — from its property of Shrinking in the fire — The purest Cornish Clay to be employed for this purpose — it first diminishes in bulk from loss of Humidity and when it approaches a red heat expands from the extrication of some gaseous fluid — but from a red heat it ~~expands~~ contracts regularly in exact proportion to the intensity of the fire Pyrometric Pieces were made of exact proportions in width breadth & diameter for this height is to

to ascertained by passing them through the cylinder and they are dried in hot water — If the relative heat (of two Furnaces) is to be examined the pyrometric pieces are placed in each respective furnace — and the pieces being duly heated they are withdrawn & thrown if haste requisite into water — They are then measured in a brass Gauge ~~[illegible]~~ consisting of two converging rulers one foot in length forming a groove between them of the width of 7/10 of an inch at one extremity & 3/10 at the other which gauge Mr Wedgwood No. 1 — No. 2 fit to divide into 240 Degrees

Mr. W. now very much wished to know the relative degrees of heat on his Scale and on that of Fahrenheit, as Glass would not bear a red heat — & as his pyrometer was not acted upon by a lower temperature than this it was necessary to employ an intermediate pyrometer and he used one of Silver for this purpose — and comparing the ratio of the expansion of Silver first with that of mercury on Fahrenheit's Scale and then with the denomination of his pyrometric Pieces he was led to conclude that one of his degrees was equal to 130 of Fahrenheit and that the

first degree of his scale corresponded with the 218th
of Fahrenheit

Mr W. has employed this principle in the Py-
rometer is constructed to very useful pur-
poses in his art — for (during the Contraction
of clay — (it loses nine of its weight) and
when once the clay or any mixture of clay has
been subjected to an intense heat & to a cer-
tain degree of heat with will cause it to contract bulk
as soon as the heat is more intense than that
to which it was before subjected it again begins
to diminish in bulk & hence Mr W. has been
able to determine exactly at what heat any
Varieties of Porcelain or of antiquity were
fired

By the assistance which the Pyrometer affords
we are enabled to ascertain the relative heat
of furnaces and the best mode of constructing
them — A Chemist the Potter or the founder
by observing any changes in the color
at a particular temp may with the greatest
facility heat his furnace at any future
time to the same Temp

Mr. then read two very important Circum-
stances to be determined

If the contraction of the Pyrometric Pieces is at every different temperature above a red heat in exact proportion to the increase of heat W. Wedgwd endeavored to determine this but his experiments are not conclusive — but still tho this question be undecided the instrument is a very useful one in determining relative degrees of heat

Another Question of great importance is whether the pieces are at all times uniform in their contraction —

W. W. laid in at first a great Cargo of Cornish clay to form his pyrometric Pieces and he found the greatest nicety requisite in the degree of humidity and the degree of compression employed in forming them — with the pyrometric Pieces thus formed he supplied most of the Philosophers in Europe but on buying a second Cargo he was disappointed to find that it did not conform with its contractile power with his former pyrometric pieces

— It then occurred to him that as the contraction of these pieces depended on the Alumine they contained — Pure alumine might be procured and this mixed with good unfusible clay

be hoped wd answ every purpose — the Pieces are certainly in this way rendered much more uniform in their contraction and infusibility but observation has proved that the difficulty is not entirely conquered even under the hands of Mr Wedgwood Son of the Inventor

Yet notwithstanding these imperfections every Potter enameller or Chemist may form to himself a number of Pyrometric Pieces wch will be uniform in their contractile power and a ~~gauge~~ gauge which which will ~~form~~ speak a language wch is intelligible to himself

— I must now resume the Subject of the nature and Effects of Calorique wch I mentioned before but cd not proceed without making you first acquainted with the Thermometer & Pyrometer — It may be observed that these Instruments do not measure the actual quantity of caloric in bodies but only the relative arithmetical difference in the Tempe of bodies — for we know little or nothing of absolute Zero or the point where heat begins — It has been before remarked that Fahrenheit supposed at first that his scale was a measure of the actual heat

at Penley Stone in Hudson's Bay the natural
cold was found to have been in 50

or Calorific bodies — and Sir Isaac Newton
seems to have fallen into a similar Error
as if he imagined the freezing point to be
Zero — "Thus he says Iron melts at four
times that degree of heat at wch water
boils — & water boils at three the heat of
the human body" — This can be true in no
sense except that Iron melts at four
times that number of degrees from the freezing
point at which water boils &c
— To shew our ignorance of Zero It may be
remarked that the natural Cold in some
parts of Sweden Siberia North America &c
are nearly 20 — 30 or 40 and Mercury has
been found freezing by Dr Pallas & others
at the Instant Mercury freezes very unlike
water it contracts greatly in its bulk at
this Circumstance led Professor of
Petersburg into a great mistake and puzzled
the Philosophers — By a mixture of Nitric
Acid & Snow he produced a congelation in the
Quicksilver wch indicated greatly contracting
in bulk indicated 500 degrees on the Scale
but the cause of this is now well known
In our own Country Mr Walker of Oxford

has by frigorific mixtures (I think Dr B. used a nitric acid & muriate of Lime / I think the alkoholic Thermometer to mercury 91
D. Irwin of Glasgow pointed out a method by which he conceived we might find Zero — this I shall explain hereafter — and it was also pursued by Dr Crawford — Mess Phelps fixed it at about 1400 or 1500 — Lavoisier & De La Place pursued the same mode but with a different result —

From these remarks it will appear that a Thermometer is not a measure of the actual quantity of caloric in bodies — but the relative or Thermetical proportion beyond a certain point — Thus the heat of boiling water is 180 of Fahrenheit from the point at which water freezes 212° from the point of Comp. produced by a mixture of Salt & Snow 252 from the point at which Quicksilver freezes but we know not how far beneath it may be from actual Zero — This may be happily illustrated by a chain both extremities of which are invisible — but if we determine on any one link as a fixed Point and reckon any number of links from it the Series we

do not learn the distance from either extremity but only the distance from the fixd point

I must now proceed to speak of the communication and distribution of heat or knowledge of wh. we now as before observed solely to the Thermometer

and first of the equilibrium of heat

If a hot and a cold body come into contact the one decreases and the other increases in heat till a medium or mean Temperature is established — This always happens between contiguous bodies except when one or more of the bodies have the power of extricating heat or is in a state of combustion This is an undisputable axiom whatever opinion we form of the nature of Caloric itself

If a number of the most different Substances as wood marble wool & iron be rubbed together or brought into contact — all of different Temp. a mean Temperature will be established as the Therm: proves for our senses would deceive us in this particular whence arises a popular error that one body is in itself cooler than another which property of

exciting the Sensation of cold depends on the
power of a body or Substance to conduct heat
An equilibrium of Temp is prevented thro
the nature but for the many Substances con-
stantly extricating heat and the causes
tending to destroy the equilibrium
— This property of restoring an equilib
depends partly on the attraction of particles
of Caloric have for the substances but it
chiefly depends according to the chemical Theory
on the repulsive property of the particles
of caloric exercis on each other
Thus if one body be in contact with another
of a lower Temp — the repulsive quality of
the Particles of Caloric in the first will drive
them into the contiguous body tho an equal
resistance is established in both
according to the mechanical Theory this equi-
librium is produced by that communication
of motion which is known to take place
between other bodies
— We must now distinguish accurately be-
tween the Intensity of bodies & the actual
quantity of heat they contain
The Intensity of Heat is that power or force

wd Calorick exists in impressing our organs with the sensation of heat or which is measured by the Thermometer & This is usually termed Temperature — The Quantity of Calorick implies the actual Store of Calorick in any Substance —

Thus If I have 5 pounds of water and separate one pound — The Temperature in the one pound is the same as in the 4 Pound but the actual properties of Calorick must be in proportion to their masses

Boerhaave was the first who proposed the method of determining the Quantity of heat in bodies viz by mixing different bodies at different Temp and noticing the Temp produced If the Temp produced were a mean point between the two it was concluded that their Quantities of Calorick were equal — if not that they were unequal and this was a Logarithmatic Ascension as in the last case the cold would be more in coming to a result Temp than the other Gained as wd gain more than the other lost

If you mix together equal Volumes or
equal weights of different Substances
at different Temp: it rarely happens that
the temp: produced is a mean between
the two Temp employed
Thus e.g. if Water of 40° & water at 100
be mixed the result is 70 or a mean Temp:
But if you mix a volume of water at 40
and an equal volume in bulk of Quicksilver
at 100 the result is not 70 but 60
that is the water loses 40 quicksilver has
lost 40 and the water has gained but 20
or in other words that Portion of Caloric wch
in leaving the Quicksilver has sunk its
Temperature 40 degrees has raised the
wt in passing into the water raised
its Temp: only 20 degrees
On the other hand if you mix equal bulks
of water at 100 and Quicksilver at 40 the
result will not be 70. but 80 — That is —
that Portion of Caloric wch in leaving the Water
sinks its Temp: only 20 degrees raises the
Temp: of the Mercury (on passing into it)
40 degrees

Experiments illustrating this

Hence it appears the same Quantity of Ca
loric which lowers any a Portion of wa
ter by any number of degrees of
will on an equal bulk of
on passing into Quicksilver, in-
crease its temperature by twice that num
ber of degrees

But if you take equal weights of Mercury &
of water — suppose 6lj of Mercury at 185°
and water 6lj at 40° The result will be 45
That is the Quantity of Caloric — the loss of wch
will sink the Temperature of Mercury 140
degrees will raise that of an equal weight of
water only 5° —
or if you mix 4lj of water at 185
and 4lj of Quicksilver at 40 —
the result will be 180.
That is the Quantity of Caloric loosing wa
ter by its loss — 1. receives in passing in
to an equal weight of mercury raises
its temp 28°

Again If you take equal weights of diff
bodies at an equal temperature and throw
into them all the same portion in Quan
tity of caloric the increase in their temp
will be exceedingly unequal different

Thus if you take three the same proportion

of Calorie into equal weights of Water
Spermaceti oil, Chalk, Iron, Quicksilver,
& Lead, & all of equal Temperature then you begin
the experiment that Quantity of Calorie
which raises the Temp of the water by
1 degree will raise that of the oil 2 —
Chalk 4 — Iron 8 Quicksilver 28 and
the Lead 29
So if water which boils at 212 — be placed
in the same degree of heat & set in the same
fire with an equal weight of Lead which
does not melt tho it arrives at 500 the
Lead will melt before the water boils
This property in bodies which disposes them
to receive a greater or less portion of Calorie
in the increase of its Temp is called its
Capacity for Heat or for Calorie
That substance is said to have the greatest
Capacity for Calorie wch suffers the least Elevation of Temperature on the injection of any
given Quantity of Calorie — and that body
or substance is said to have the least ca-
pacity for heat wch suffers the greatest Elevation of its temperature on throwing in any
given Quantity of Calorie

The Capacity of a substance for heat is in
exact proportion to the Quantity of Caloric
necessary to raise it to any given Temp.
and its relative Capacity for heat is in
the inverse ratio of its increase of Temp
on the injection of Caloric any given Quantity
So Water is said to possess 28 times the
Capacity of Quicksilver as it requires the
ingress of 28 times more caloric than
Quicksilver does in order to raise them both
to the same temp.

And another circumstance I must notice
which we shd certainly a priori expect
that those bodies wch have the greatest capacity
for heat give out the greatest Quantity on
Cooling Thus a pound of water lost as much
caloric in lowering its temperature one degree
as Mercury loses in cooling 28 degrees

We are indebted to Fahrenheit for this Invention
and to Boerhaave for recording the mode of
investigating the capacity of bodies — But
the first who fully understood the subject &
drew proper inferences from it was Dr Black
Dr Irwin of Glasgow examined the relative

Capacities of many different Substances and applied the doctrine to the explanation & illustration of many Phenomena in Light & Caloric — Dr Crawford extended them experiments applied them to the illustration of many other Phenomena connected by Dr Irvine

This Subject has since been greatly elucidated from the researches of Magellan Lavoisier and D. La Place

There are two modes of investigating the capacity for Caloric of different Substances — the one is that of Boerhaave — by mixing two heterogeneous Substances of equal weight (which is always supposed when the contrary is not expressed) at different Temperatures and knowing the result and the relative Capacity of each substance is in the inverse ratio of the increase or decrease of the result from the mean Temperature to the loss or gain of Temperature

Thus if A at 100° be mixed with B at 40° & the Mixture be 60. The relative Capacity of A to B is as 1 to 2 —

But if the result be 80. The relative Capacity of B to A is as 1 to 2

In determining the Capacity of different Substances for Calorie the Capacity of water is taken as a Standard for 1 or to prevent Fractions 1000

If a substance is to be examined which is soluble in water causing a Chemical action the result might be fallacious and therefore those Substances are mixed with Quicksilver or Oil & their relative capacities estimated accordingly — or it may be done thus

If Sulphuric Acid is to be examined for its relative capacity, this Substance when mixed with water causes a Chemical Revolution or Evaporation of part therefore equal quantity of weight of water and of Sulphuric Acid are to be heated to an equal & a high Temperature and a quantity of powdered glass is added to each the tube they both are lowered to a low & an equal Temperature and their relative capacity must be in proportion to the glass added — or in other words to the quantity of Calorie substracted from them to reduced them to the temperature required —

The 2d mode of measuring the Capacity of bodies is by the Calorimeter — The body

to be examined is heated to a certain
Temp & its Capacity measured by the
heat given out in cooling w.ch is deter-
mined by the Quantity of Ice that is melted
Thus take water at 200 reduce it to the
Calorimeter to 32 & measure the water
from the melted Ice
Take out the substance at 200. reduce
this also to 32 - measure the water from
the melted Ice — The capacity of the last
body is to that of water (in the exact ratio
of the difference in the Quantity of melted
Ice) as the last product of water to the
first
This is perhaps the nicest mode but is
subject to the difficulties before mentioned
when speaking of the Calorimeter
The Capacity for heat in bodies is not in
proportion to any other property they possess
Chemical or Mechanical nor has it the
smallest relation to their susceptibility of
Motion
To give some general Idea of the difference sub-
sisting between different bodies with regard
to their Capacity for heat I may just

remark, that taking the Capacity of
Water as a Standard at 1000 the Capacity of
the Air of the Atmosphere is 1790

Alkohol	602
Spermaceti Oil	570
Arterial Blood	1030
Solid Parts of the Lungs	709
Lean Beef	740
Rice	506
Wheat	477
Oats	466
Chalk	256
Iron	125
Copper	111
Tin	70
Lead	35

And as a general Observation it may be noticed that aeriform Fluids have a greater capacity for heat than fluids and fluids than solids

The Capacity of Bodies is expressed by Dr. Crawford under the term of comparative heat and the Distance from Zero or absolute Privation of heat he terms the absolute heat of a body

The Temp of bodies may be changed in two ways — by adding to a substances Calorie and — by changing its Capacity If the Capacity of any substance was altered so as to diminish only one half — the same quantity of Calorie would raise it 5 degrees not raise it 10 degrees and the Temp reckoning from absolute Zero would be doubled

Is such a change possible in the Capacity of a body. — If a solid is changed into a fluid or a fluid into gas its Capacity is materially changed — but D. Crawford has endeavoured to prove that while bodies retain their form, their Capacity is not materially altered — He found by many and easy experiments that the Capacity of a variety of bodies from freezing to a boiling heat was unaltered — and by analogical reasoning he concluded that this was true of all the Temperatures This conclusion however is scarcely warranted — for it has been found that the Capacity of dilated Sulph. Acid — the Capacity rises as its Temp increases and this may be true for aught we know of other substances

But D. Crawford assuming this Principle as proved

made it the fundamental Principle for discovering the real Zero That he shewed The absolute heat of a body may vary in three ways
1 From the Quantity of the body as this of water contains more caloric than 4
2 From the Capacity of the body for Caloric — Thus as water has 20 times the Capacity of Quicksilver It must contain weight for weight 20 times as much matter of heat if the real capacity be supposed equalized from Zero
3ly It varies from the Temp at which any body is taken as Water at 40 contains less than Water at 50 &c — Hence it is inferred that if equal Quantities of two different bodies are taken at the same Temperature — The absolute heat of the one to the absolute heat of the other will be as the Capacity of the one to the Capacity of the other
But there are two circumstances required in order to make this Conclusion legitimate ——
1st That the capacities of bodies remains unchanged from Zero to the Temp at which the experiment is made as was observed before

Now the ascertaining of this point does not appear to me of very great importance — for if the Capacity of a body is increased — I presume there is with this change of its constitution such an increase of Caloric as entirely to satisfy its

menace of Capacity — In xxxx the Postulate is
2dly That the whole Quantity of calorie wh enters into any substance be retaind in that substance by its Capacity, and that the Calorie in every body is indicated by the Temperature of that body But the Genral belief of Chemists is that Calorie enters into a state of Combination with other bodies forming one of their constituent Principles If so the Position of Dr Crawford cannot be correct
— Then exists a great difference in the facility with which heat pervades different Substances but the conducting Power of bodies as it is called cannot be discovered a priori as it has no relation to any chemical or mechanical Property — Bodies that are good Conductors of Electricity are generally also good conductors of Heat but this is not universally true and generaly too the most dense bodies are the best conductors of Calorie — but this too has exceptions
Mr Ingenhouz endeavored to ascertain the Ratio of conducting Powers in different Metals by coating rods of equal diameter with wax & applying the same heat to one extremity of each rod & calculated from the melting of the wax but this calculation must be very inaccurate According to him Silver has the greatest conducting Power then Gold Copper Tin Iron Lead Steel

Lead Platina — Plesp the a very dense body is a very bad conductor of Caloric so are Vegetables & especially charcoal especially powdered charcoal — and generally speaking all light spongy & soft substances are bad conductors in proportion to their sponginess

Fluids are good conductors of heat as it is generally applied but very bad conductors and indeed Dr Rumford says they are nonconductors if the heat be applied in a certain form

It has been estimated pro ratio that if the conducting Power of Quicksilver be 100 that of moist Air is 330. Common Air 80½. Rarified Air 78. Vacuum 55

These remarks and the differences have pointed out one of more importance than at first might be aware imagined — Thus if we wished to communicate heat hastily we shd employ a good conductor & vice versa — Hence a popular error to suppose that wool or Cotton communicate heat or the contrary in the hot countries when the has been procured and they wish to preserve it it is wrapped up in Flannel

— We were proceed to speak more particularly of

The Laws according to wch it has been found by experiments that bodies put into a gain their Caloric is acting an equilibrium — As the circumstances relative to the cooling of bodies are most readily ascertained and as they much be heated - we take it understood in the same ratio that they are heated - most of an experiments have been made on cooling bodies

If a body is charged with more caloric than the neighbouring bodies it passes from it to restore the Equilibrium in two ways — Radiation and communication — When the medium is transparent thro which Caloric is communicated - it passes thro it by radiation communicating no Caloric to the Medium thro wch it passes but it strikes on some fixed substance wch intercepts the rays of Caloric

The Capacity wch any body posts with its caloric depends on 1 The Temperature to wch it is heated - The higher the Temp the more rapidly does it pass off - imparting less & less Caloric as it grows cooler - Sir Isaac Newton laid down this as a rule, As the Terms of Temperature increase in an Arithmetical Progression

so the Quantity of Calorie given out decreases in Geometrical Progression — but when the Temp approaches to an Equilibrium — as the time increases in arithmetic Prog: so the Decrease proceeds in arithmetical Progression

The Rapidity of Refrig: depends 2.dly on the Magnitude of the body — Take two bodies of the same shape but different Magnitudes they cool in proportion to their diameters not to their bulk thus a Cube when solid Content is one Inch cools in one third of the space in which a cube cools when heated to the same Temp whose solid content is nine Inches

3.dly on the Figure of the body, for then bodies part with their Calorie most rapidly wch expose to the cooling medium the greatest extent of Surface — consequently spherical bodies cool with greatest celerity caeteris paribus than any others

4.th on the particular Nature & Constitution of the body — as a difference of Capacity, or of conducting Power — Then bodies cool with greatest celerity that have the least capacity — Thus Quick silver having half the Capacity of water cools bulk for bulk caeteris paribus in half the time or caeteris paribus the Rapid with which any body

heated cools in proportion to its conducting power — as it is communicated from the internal Parts of the body to the Surface with greater or less celerity

5 On the Nature of the abstracting medium as it is necessary or frequently changed as it has greater or less Capacity for heat, for the greater its capacity the faster it abstracts Caloric from the heated body — as its conducting Power is never less great.

— It is from hence that a piece of marble feels so much cooler than a piece of wood — as the marble is a much better conductor of Caloric than wood

Hence too the Earth is prevented from being deprived of a great portion of Caloric by being covered with snow which is a bad Conductor of Caloric and the tender grain is in the same manner defended

Accessory Causes is caused in the rapidity with which any substance cools if the cooling medium be constantly changed — hence it is that the air is so much cooler when apparently when the wind is brisk

If a Solid body be cooled in a Fluid there is a continual change of the Particles of the medium in

w^h the heat body is immersed or suspended
Thus if you hang a bar of heated iron in the
air of the Atmosphere — Two Currents may be
distinctly perceived — one above upwards caused
by the particles of air which have been rarefied
expanding — and this of course is a very warm
Current — another may be perceived from below or
caused by the pressure of the surrounding air into
the Vacuum — So if Spirit of Wine be heated and Rosin
suspended in it Two Currents may be remarked
the rarefied Alkohol ascending & then the Less
not rarefied descending — Thus in a crowded
apartment if the door be opened and there be
no other Ventilator two Currents may be per-
ceived ~~in the~~ one at the Top outward the other
at the Bottom inwards — and in a Theatre
the greatest degree of Heat or is felt by those in
the upper seats — These Circumstances & others
of a similar nature have given rise to the
vulgar Error that heat ascends
Thus it appears that in the Construction of a
Furnace the Heat should be applied to the Bottom
for if the Heat be applied to the top — the ~~top~~
particles heated and expanded by the Heat will
remain at the top and to cool any fluid the
cooling body shd be applied at the Top ——
If a Jar be filled with heated Alkohol and two

Thermometers immersed one near the top the other at the Bottom tho care be taken that the alkohol cool from the surface only yet ye lowest Thermometer will not indicate a Temp. so high by 3 4 or 5 degrees as the higher one

(M. Petit made some Exper. to prove that Caloric has a tendency to ascend but they are inconclusive)

Hence it arises that the parts of a fluid know but little rest if any part is warmer than another or if ye Temp of the Fluid be different from any contiguous body — Thus deep lakes remain unfrozen when shallow lakes are covered with Ice, as the winters in this Country are not sufficiently long to produce such an interchange of Particles as is necessary that the whole bulk of the water may be sufficiently lowered in Temp. —

— But with regard to water there is one singular Circumst. noticed by Ct Rumford that it is not requisite that the whole mass shd be changed to 32. for when water sinks below 40 the increase of cold no longer diminishes & expansion of its Particles these Particles no longer sink

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and the surface only is cooled and frozen the Body of ye water remaining at 40. by which wise provision of the great Author of Nature the unnecessary expend: of a great Quant of caloric is prevented.

But Salt Water still continues to be contracted by cold after 40. and hence a great Quantity of Caloric is imparted to the Atmosphere wh renders our insular Situation so much milder, as Dr Pallas has found that in the same Latitude as England or ye Centre of Switzerland that Mercury began to freeze

One exception however appears in the Air of the Atmosphere for as you ascend in the Atmosp the Temp becomes more and more cool till you come to region where there presides an eternal frost

This under the line is at the distance of 15,577 feet

surface 10 degrees latitude	15.077
30	11.592
55	4.912
70	1.557

In this Country the Thermomet sinks one degree at the distance of 200 feet from ye surface ~~two~~ 2 degrees at ye distance of 400. 3d at the distance of 1200

Some Anomalous appearances are noticed by
M. Pictet from expts made at Geneva.
He suspended two Thermometers one at the
distance of 5. & the other of 75 Feet from the sur-
face — they were at the same height 2 hours
after sunrise but at noon the highest was 8½°
lower than that near the surface — and at midn.
it had become 8½ higher than that near the
surface, I shall not detain you by entering into
an explan: of these Phenomena — but he ob-
serves (I may remark) that the Phenomena
were always nearly the same except in very
windy stormy weather
But to an. for the Coldness of the Air in elevated
Situations I may remark that the Suns rays,
cause heat only when they are obstructed and
absorbed — Air is exceedingly transparent
but as it approaches the earth it becomes
more dense & filled with Vapor & these intro-
cepts some of the rays, but the greater Portion
of that of the atmosphere is derived from the rays
falling on the Earth which excites their Caloric
& imparts it in a great degree to the Air —
For the Earth Heat received by the Earth does is
exceedingly slow in penetrating below the surface or
the Earth is a very bad conductor of Heat
Thus in Geneva it was found that at the

depth of 29 feet from the surface the heat was greatest at Midwinter & the thermometer lowest in midsummer & it is inferd that the Earth conducts Caloric only at the rate of 29 feet in six months)

But tho the Air when thus heated by communication of Caloric from the Earth does not ascend for the expansion caused by this increase of Temp. is not sufficient to overcome the greater condensation arising from Compression & Elasticity of the incumbent atmosphere, and in the former experiment of cooling a solid in a fluid medium the fluid ascended not simply because it was heated but because its specific gravity became less than that of the incumbent Part of the Fluid

D. Lee is of opinion that the Ether, in its composition like the Air near the Earths surface & that it expands as heat the Sunns rays produce no heat above the surface because they do not meet or combine with the Ether suspended to be the base of Caloric — but if there exist there I cannot agree with him

Dr Count Rumford contends that Fluids comprehend aeriform Fluids are entirely non-conductors — that they readily and regularly convey transport Caloric from body to body but bounds

transmit it in any degree from Particle to Particle — What first gave rise to this Idea was his having been scalded by a Jet of Steam very sensibly feeling that it retained its Caloric a long time, and knowing that 40/50 of its Parts consisted of water — he made some experiments with Flour endeavours to prevent the motion of the Water as interspersing Dense or Starch and he infers from these experiments that if the water were perfectly motionless it would be a bad Conductor of Caloric — The use of this he observes will be obvious as fruits &c are enabled to endure frosts much longer than they could provided the water which is a considerable constituent part of all Vegetables were a good Conductor of Caloric — The Conclusions of Mr Rumford however need not be rashly drawn he knows that if Water were a Non-conductor of heat were applied at its surface when perfectly at rest it would not pass downwards He poured on a Cake of Ice a portion of Water at 32 then very carefully a much larger portion of boiling water — and it was a long time before any part of the Ice was melted Then in place of boiling water he added water of the greatest Specific gravity i.e. at 40. and it melted

with considerable rapidity. He then made some experiments with Quicksilver and with Oil & it appeared that they however were no better conductors than water. Then he introduced into a cylinder a piece of Ice and filled the Cylinder with Oil — then he immersed with great caution a piece of hot Iron (covered with pasteboard) but it was within 2/10 of an Inch of the Ice and after some time it did not appear that any of the Ice was melted — he then made a similar experiment in almost every circumstance with Quicksilver when if the smallest Quantity of Ice had been melted it must have been detected but the result was the same as before

These portions of the Course he concluded with the mechanical theory of fluids an expanded susceptible of motion — & nothing is better known than that density with which sound is conveyed both by Air and Water

(The Comment of the Courts opinion experiments on Air I must defer till a future period.)

I have since made many experiments to determine this point and have found that Water Oil & Quicksilver the very bad Conductors of Caloric were not positively imperious — the Courts suppose that there must have been

some motion in any experiment — but on the other hand I must be permitted to think that the exp. of the Count were continued for such a time and were chanced that it have a long time before it transmitt Caloric and it permeates the Earth only at the rate of 2 Inches a day — so that its progress would hardly be perceived in a few minutes

Another objection to the Counts conclusion is that if two portions of the same liquid be mixed together the one at the height the other at a lower temp a mean result is acquired now if water does not transmit its caloric from Particle to Particle this mean can be no other than a Mixture of Particles of unequal Temp: but if that were the case being of different Specific grs they would separate — the warmer & therefore more expanded Particles to the Top — the cooler & denser to the bottom — but on experiment we do not find such a result — If Oil of 118 and water of 40. be well agitated together and then suffered to separate — on a Thermometer being introduced into the water & another into the oil both indicate the same Temp 78 —

D. Thompson of this Place has made some experiments which have led him to conclude

that tho watery fluids are bad Conductors they are not positive nonconductors If this were proved the Counts discovery must still be allowed of great importance and his positions deduced from his theory relating to the Economy of nature may still remain equally true

Before I quit this subject Permit me to repeat that the doctrines I have been deliv^{d} are applicable to many useful Purposes in the construction of furnaces & all vessels where heat is to be applied of Refrigeratories Ice houses &c Count Rumford has a Cylinder introduced after supper for Punch &c with two stopcocks hot water at the top and cold at the Bottom and he had a pye with wch he was much pleased consisting of a very hollow crust at top well baked and Ice cream at ye bottom unmelted

You will also recollect that when any body is to be kept of an invariable Temp^{r} it may be surrounded with some spongy substance wch is a very bad conductor as it contains a great Portion of air

II I come to speak of the next Effect of Caloric Fluidity – In some bodies this takes place

immediately instantaneously as in Lead &c copper &c - in others more slowly as Butter wax &c &c This effect wh consists in the breaking down the Attraction of Cohesion so that the Parts of ye bodies can move freely among each other is ascribed to ye repulsive power in the Particles of Caloric itself. Bodies thus rendered fluid return on the abstraction of their caloric to a solid form the effect of expansion from caloric is universal & the effect of fluidity is very generally we must of course except substances too volatile to admit a sufficient application of heat - & it has not yet been shown that earthy substances could be rendered fluid - but this we have reason to believe from analogy arises from our being unable to apply a sufficient degree of heat - a few years since Platina was deemed an infusible substance for the same reason but we now know that it may be melted

A solid is considd as being the natural State of all bodies and all fluids as solids melted by a lower degree of Heat than that of ye air of the at. Some years since it was thot impossible to freeze mercury or Ether but I hope to give eye proof of the practicability of this - but the greatest degree

of cold hitherto produced have not been suffict to freeze ye purest Alkohol Naphtha & some essentl oils —

The degree of heat at wch any body melts or (wch is the same) at wch it becomes solid is uniformly invariable — It is true that very pure earths admit of being melted tho ye coarse earths do not that mixt metals melt at a lower temp: yn the mean of ye point at wch ye metals employd wd melt & also that water when mixt with Salt requires a much more intense cold to melt it than water unmixt but the same identical fluid always becomes solid some at the same identical temperature & vice versa.

If caloric were abstracted Philosophers infer that all bodies wd become solid — & Caloric is considd as the only body essentially fluid imparting their fluidity to all other fluids

It is a popular opinion that in order to the freezing or melting of any body nothing more is requisite than an increase or reduction of Temp this however is erroneous

If a quantity of Ice be brot into a warm Temp. 40 it is a long time before it melts and remains always at the Temp of 32 itself till completely melted

so likewise if water be subjected to an air of w^{ch}
the Temp is 30 or lower it is a long time in freezing
and always freezes at 32

Pure water may be reduced especially in vacuo
almost to Zero — taking care to keep the vessel steady
without its freezing — then on agitating it immedi^{y}
it starts to ye Temp. 32 & congeals

This proves that something more is required
than mere reduction of Temp. & Dr. Black was
the first who pointed out the cause of these Pheno
mena tho' De Luc very impertinently disputes his
title to ye honour of ye discovery — The Doctor ob
serving how slowly Ice melted & always at the
Temp of 32 ~~altering~~ absorbing so great an influx of Caloric
without any increase of Temp concluded that
the caloric on entering the Ice as it was melting
must pass into a latent state — he therefore
denominated it "Latent Heat"

Exper: I here take water at 32 & an equal Quantity
at 212 on mixing them the Therm indicates the
mean Temp. 122 — I now take equal Quanti
ties of Ice at 32 and water at 212 on mix^{g}
them The Ice melts rapidly but the mixture
continues at 32 — what is become of the Quantity
of caloric no longer obvious to our senses —

in the language of Dr Black it has passed into a latent State — So when water is expand to a very cold air it remains at 32 when it begins to freeze but the whole is frozen in this case it gives out a great Quantity of Caloric to the air immediately air is without any variation of Temp & there must have been some latent Quantity of Caloric to support this Effect — if the water is cold to the 20° before it begins to freeze there must be some Quantity of latent Caloric which is evolved the moment its Temp rises to 32 & Congelation commences In order to determine the Quantity of Caloric absorbed by ice when converted into water Dr Black filled two Florence Flasks with equal quantities of water at 32° he then caused the water in one of the Flasks to freeze — after this he expand both to a Temperature 40. The water absorbed a sufficient Quantity of Caloric in the first ½ hour to raise its Temp 7 degrees — The ice required to be subjected to the same Temp 21 hours before it was melted this determining what the latent increase of Temp at 32° —

Dr Black Thereby very fairly infers that as much Caloric was absorbed by the water

melting Ice as w^d have elevated the Temp^r of an equal quantity of water by 21 times 7 degrees or by 147°. The next experim: was more satisfactory, for mixed with 4/5 of Ice 4/5 of water at 172 wch was just sufficient to melt the Ice without elevating its Temp^r by the least particle of a degree beyond 32° ——— if water of lower Temp^r than 172 were employed the Ice would not be melted — if of a higher Temp^r than 172. the result of the mixture w^d be somewhat higher in proportion — Consequently in these exper: there must be an insterp of so much Caloric into the Ice in order to its liquefaction as w^d raise the Temp^r of an equal bulk of water 140 degrees — Dr Luc & Dr Crawford agree with Dr Black in making the quant. of Caloric thus becoming latent equal to what w^d raise an equal bulk of water 140. but W. Cavendish 150. Wilkie 138. Lavoisier 135, When Water on the other hand is frozen it is concluded that an equal quantity of Caloric is given out. Dr Crawford endeav^d to establish this by experiment — Puts water cold to 4° & drops a particle of Ice the whole

instantly started to 32. and one fifth was
converted into Ice — Now the Quantity of
Calorie given out by the portion frozen must
have been sufficient to raise the whole to 32°
that is 28. degrees — if 28 be multiplied
by 5. the Product is 140. but this experiment
is not quite so satisfactory as those preceding

This constitution of things answers the wisest
purposes in the Economy of Nature as it must
be obvious to every one that that would have
deluges and inundations the human race if Snow
& Ice were suddenly to melt

Arguments have been founded on these experiments
to prove that Calorie is a distinct Species
of Matter as it is impossible to form any con-
ception of "Latent motion"

It now became an interesting object of enquiry
whether these Phenomena were confined
to water and the many experiments have
not been made with regard to those substances
of so fusible a nature as those above mentioned
it is evident that these appearances are not
particular but universal — and in all these
experiments the Temp. of the congealing or
melting substance always remains unaltered

tile the whole is congealed or melted notwithstanding the great ingress or egress of Caloric wch takes place in their respective Processes whence we infer that if so much Caloric enters a body without encreasing its Temp: or leaves it without diminishing its Temp it must exist in that body in a latent state

Dr Irvine of Glasgow made some experim on Tallow Wax ~~and~~ Spermaceti and Sulphuric acid - and in all with a similar result

But it shd be noticed that when any fluid is cooled below its freezing Point and then by agitation the process of freezing begins - only a part of the fluid congeals and this is greater or less in proportion as the fluid was more or less below its freezing Point - so in the experimt of Dr Crawford just related the fifth of the water was congealed on agitation when it had been previously reduced to 4°

This may be illustrated by the sheeting of Copper, when ye Copper has been refined and it is reduced to a Temp very little higher than that at wch it congeals a jet of water is thrown on it a Part of the Copper becomes a solid sheet on the Top this sheet is removed & a 2d Jet of Water thrown on it then a 2d sheet is formed &c &c

The adequate Quantity of Calorie absorbed by Water on passing into a fluid state from a solid state was said to have been sufficient to raise it from 140 degrees — That absorbed by Tin & Crawford computes it so much as would raise the Substance 500 Wax 170 Spermaceti 150. but it is to be remarked that the actual quantity of Calorie absorbed by these bodies in passing from a Solid to a fluid state are not in the ratio of the above numerical figures for it would raise Tin 500 degrees would not raise water half so many as it does of their different Capacities

What has now been advanced will illustrate the cause of the production of Cold in freezing mixtures —

Exp: with a cylinder containing a Portion of water plunged into a Mixture of Muriatic acid and Ice — The Ice being rapidly dissolved absorbs the Calorie from the water contained in the Cylinder in consequence of which it is frozen —

Reverse Experiment with a saturated Solution of Sulphate of Soda in which a Thermometer

is immersed — On dropping in a small portion of the same substance (Glauber's Salts) the fluid begins to crystallize or passes into a solid form — a quantity of Caloric is extricated w.ch had before been latent and the thermometer rises 8 degrees

A Fluid then is to be considered as a compound body of which one ingredient is Caloric some have called Latent Caloric combined Caloric D.r Blacks Theory deduced from these experiments was that the Disengagement of the Latent Caloric was the cause of a fluid entering into a solid state. but that the Particles of the fluid having a great Attraction for the Caloric did not part from it tho a slight agitation or some such Circumstance favord the new arrangem.t and that this explains the experim.t of Fahrenheit where Water was reduced to 4.° before it began to freeze — But D.r Irvine proposes another Solution he supposes that these Phenomena are the effect of a change in the Capacity of the body when passing from a solid to a fluid or from a fluid to a solid State — He determines the Capacity of water to the Capacity of Ice to be

as 10 to 9. and he imagines that the instant that any Quantity of Water passes into the state of Ice its capacity is diminish'd 1/10th & therefore it gives out in a sensible form one tenth of its caloric & vice versa when Ice passes into a state of water its Capacity is increased in an equal degree & it absorbs 1/10th more Caloric than it before contained — It was on these principles that this ingenious Philosopher estimated the real Zero For if the difference between the Capacity of Ice and of water be 1/10 and this 1/10 be as Dr. Black has computed so much as will raise the Temp of water 140. degrees — then Multiplying 140 by 10. we shall infer that the whole quantity of actual Caloric contains in water at the freezing Point estimated from real Zero is when equal to 1400° of Farhenheit

This is certainly very ingenious but Experiments must be made on other substances before a warrantable conclusion can be drawn

The Rule for these experiments is

Multiply the number of the expressing the relative capacity of the fluid, into the number of degrees which enter into this fluid in it's usual solid

$$\begin{matrix} 10 \\ 140 \\ \hline 1400 \end{matrix}$$

Divid the Product by the difference between
the capacity of the fluid & that of the same
fluid when it has become solid — } 1)1400(1400

But the justice of the inference must depend
it is said on two points wch have not been
ascertaind — 1st That the ingress of Caloric
depends on the increase of the Capacity of the
melting body solely and on nothing else
2dly That the Capacity of the body remains the
same from Zero to the Point at wch the experimt
is made, — And even if these were de
termind it wd be necessary to ascertain with accuracy
the Quant of Caloric wch enters a body at its
liquefaction which Quant in water Mr Caven
dish makes to equal 150 — Lavoisier 135 only
wch discrepance wd cause great difference in the result
and what is of more importance we must de
termine with precision the relative Capacity
of the body in a Solid to the same body in a fluid
State For tho Mr Irvine makes the difference
of Capacity between Water & Ice to be as 10
to 9 Mr Godolin of Upsal in Switzerland
makes to be as 10 to 5.

Dr Black then considers this absorption of Ca
loric as the Cause of fluidity Dr Irvine as

as the effect — Dr Blacks Theory seems to explain the agent by which the cohesive power of solids is overcome w^h Dr Irvines Theory does not nor does Dr Irvines conjectural Hypothesis explain the Experiment of Fahrenheits Ice in which the water descended to 4° before it began to freeze whereas Dr Black considers it as owing to the attraction of the particles of water for Caloric

Permit to state it as my own Opinion that the truth lies between the two that a portion of the Caloric absorbed is employed in overcoming the cohesive attraction of the solid & melting it and another portion in satisfying its increased Capacity — but what these relative proportions are I can by no means pretend to determine

to Dr Black from the Quantity of Caloric w^h enters into Ice in its being converted into water made some experiments to determine if this Portion of Caloric had any sensible weight — but no measure of w^h could be obtained — Dr Fordyce of London many years ago related some experiments made with a very nice balance in w^h quite contrary to expectation the water seemed to acquire an increase of weight by being converted from a solid

to a solid State and some Philosophers imagine that Caloric was absolutely light & possessed of positive levity — Dr. Franklin started this Idea & endeavored to account for it on the principles but these experiments were contradicted by them — Mr. Count Rumford instituted with a Balance sensible to the millionth part of a grain — On his first attempt it is observable that the result coincided with Dr. Franklin's opinion, but the fallacy was discovered in repeating them with greater accuracy — he procured 3 Flasks of similar shape filled one with water another with Alcohol & the third with Quicksilver he introduced them into a room of Temp. 30. hermetically sealed and adjusted by means of Silver wire with the greatest nicety to a similar weight

The water when frozen was again suspended to one arm of the balance the Alcohol to the other & they still perfectly coincided in weight — The water was remelted & ale was brought into a Temp. of 50. tho they had gained that Temp. on being weighed again not the smallest difference could be perceived —

But the Count very justly remarks that of these substances are weighed in a Torricellian Vacuum from this cause the Currents of air that are produced will materially alter the balance The Count concludes and I think not without good foundation that all attempts to weigh Caloric will be fruitless — that it may not be positively without gravity but this is too trifling to be determined by our instruments.

III The next Effect of Caloric is Vaporization by which I mean the conversion of a solid or fluid substance into a rare substance occupying a larger space very elastic and invisible Esp with Other Demonstrating This Effect This is attributed to the particles of Caloric surrounding those of the dense body and by their repulsive power overcoming their attraction & separating them further & further from each Other

Esp with water Vapor elastic colourless and invisible — vulgar Error that we see steam the Vapor of water but this is the vapor condensed — In most transparent bodies the vapor is transparent in opaque bodies the vapor is opake Esp. with acid of Benzoin

this first becomes fluid then volatilizes — it retains as it usually the case the same form as long as the elevation of temperature also it evaporates continues and on the reduction of this temp returns again to its pristine form — this it is that constitutes the Principle of distillation the body evaporates by heat and is condensed by cold — there are however some exceptions where bodies when rendered gaseous by heat retain that permanently elastic form — Experiment with dilute nitrous acid & alkohol, mixed heated — vapor received in a bladder the Gas thus forcibly expelled from the bladder by pressing on its sides and the stream of Gas ignited by a candle as it issues forth

When bodies burning permanently gaseous & elastic form a new dense form — generally undergo some chemical change in the constitution of their particles

The vapor arising from water has been said to be 14000 lighter than the water itself But Mr. Watt & Messrs Jun accurate experimentalists have found it to be only 1730 — To determine this a small portion of water was put in the

bottom of a flask & it was boild till the last drop
was evaporating – Flask was instantly corked
& cooled – the water or condensed vapor which had filled
the flask instantly collected & weighed – This
compared with the Capacity of the Flask to
give the result required
Thus it appears that the vapour of water is
but of about ⅓ the density of atmospheric
air
Different Substances require different degrees
of Heat to convert them into vapor – hence
have arisen the Terms fixed and volatile
but nature exhibits every Gradation – Other
Alkohol Water Sulphur Antimony Gold each
require a greater degree of Caloric than the
preceding to render them vaporous
Nor can it be forgotten to remind at what point the
one term shall end and the other begin to
be appropriated
But in this effect of Caloric – Vaporation – uni-
versal, neither Iron Platina nor any of the Earthy
bodies except Baryte have been converted
into vapor but the conclusion we are to draw
from analogy is that they require a higher
Temp than we are able to apply to them

When Heat is applied to bodies they generally
become first fluid & then evaporate but in
some instances they assume the gaseous State
without passing thro the fluid e.g. Am-
monia
When a fluid boils there is a considerable heat
lost in it. This has been attributed to the air they
contain but this is expelled before the fluid
arises to so high a Temp.r — The real Cause is
the expansion of the water into vapor at the
bottom of the vessel w.h rising to the top is
exploded — In such Vessels the vapor being
condensed before it reaches the surface and
the water rushing into the Space evacuated which it
occupied caused a "concussion" w.h in glass
vessels might occasion a fracture
If Heat is applied to the top of the fluid no
ebullition is produced

The Temp.r at w.h any body melts is always
the same under the same Circumstances
But as the pressure of the air has a great ef-
fect in preventing a combination that
occasions in the particles of the Body which
Caloric has a tendency to produce — as as
this pressure is liable to considerable varia-

it must produce a density in the Fluid at which any substance melts — and in the degree of Expansion in the body after its expansion there are two modes of diminishing the pressure of the atmosphere on Chemical the other mechanical

Water boiling — so that the steam may exclude all Air — This after it had been at least 15 Minutes expanded to a Temp of 48 or 50. It was made to boil by pouring in it a portion of cold water which by condensing the vapour in the Top of Barely summit the pressure caused the water to boil but by plunging it in hot water & immediately expanded the vapour the boiling was instantly stopped

The mechanical mode is that by the air pump invented by Boyle — Two parts of hot water at 212 and 1 part of cold water being mixed and placed in the receiver immediately began to boil — The ebullition depends on the diminution of the resistance to the expansion of the body by Ether

From the experiments of Mr. Watt Hot water & other fluids boil in a receiver rarefied

vacuo at 140 degrees lower than when under the ordinary pressure of the atmosphere

Thus in vacuo water boils at 72 instead of 212
Alkohol 34 174
ether minus 40 100

these bodies begin to be converted into vapor before the ebullition commences which makes it difficult or almost impossible in these cases to exclude all pressure

From these observations it is very rationally inferred that were there no pressure there w^d be no fluid in nature

Camphor Oxyd of Arsenic Muriate of Ammonia & many other bodies become fluid instead of passing imm^y into ye gaseous st- if you increase ye pressure

Water may be heated by pressure to a red heat without evaporating See Papin's digester

The expansive force of water is so great that it has produced the most violent Effects when a portion of it has been suddenly heated e.g. at the bottom of moulds for casting metals &c violent Explosion in ye Black Furnace at Colebrook dale See the article Steam in the Encyclopedia The expansive force of

water or rather the steam arising from it in
vacuo when at 32 raised a Column of 2 inches

	Inches
32	1/10 or .1
at 50	2/10 .2
100	2,6.
150	6,7
210	28,6
212	29,0
250	66,8
280	195,

The presence of Alkaholens vapor something more than one tenth part of water at every given Temp. Hence it has been proposed to employ this Substance instead of water for steam Engines &c. it would be done without waste of fluid ——

The boiling Point of water on some of the highest mountains in Europe below 180°.

I again repeat that the Temp. of boiling water is under the same Circumstances invariably the same and consequently every increase of the heat applied will not increase the Temp. of the water but only the rapidity of Evaporation ——

The surface applied to the fire should be large and when the Temp. of boiling water is all that is required a great deal of Fuel may be saved by

to these circumstances — To these positions has-
ever there appears one remarkable exception
that if a drop of water be poured on a Plate of
metal about 230 or 240° it evaporates in
a single second. but as the plate becomes hot-
it is longer in evaporating — it is seven seconds
in evaporating from the surface of melted Lead and
30. from that of melted Iron — This Surface
becomes more and more clear. to a dull red heat
& then it again evaporates more & more rapidly
as the heat of the metallic Substance increases
The Cause of this is — that after the Iron
&c. acquires a certain degree of Heat — on dropping
upon it a small portion of water the inferior surface
of this water is instantaneously converted into
vapor — this vapor is interposed between the heated
body & the remaining portion of the water and
this remaining portion in reality is not in contact
with the heated body — and the substitution of
vapor being a bad conductor of Caloric — The
Caloric from the heated body cannot enter readily
into the water

In order to convert water into Vapor it is
vulgarly believed that nothing more is required
than to elevate the water to a sufficient temp-

Mr Watt from later experiments has stated the conclusion that the Quantity of Caloric which enters into water on being converted into Steam is as much as would elevate its temperature to obtain the form of water 950. or 1000 degrees

but this Dr Black has shewn to be equal this latter — If the Temp of water be limited to 212 the Evaporation of the whole of the water does not take place immed: but is a gradual process the water & the Vapor still containing 212 — notwithstanding the Quant of Caloric contained by Vapour & in form of heating Cause — Dr Black placed a number of Vessels of various shapes but with an equal inferior diameter — with a certain portion of water in each at 54° — on an equally heating Cause the water rose in all of them to 212 in 4 Minutes — The Temp: then remained Stationary and in 20 Minutes the whole Quant of water was evaporated. The last drop being no more than 212 in Temp: Dr Black justly presuming that the same Quantity of Caloric was entered the water during the first 4 minutes must have entered in every succeeding 4 Minutes computed that as much Caloric was necessary to convert it into Vapor as would have raised its temp (provided it had not evaporated) in addition the Temp of any other body of the same Capacity 790 degrees

See Note (1)

But this Calorie not having caused either in the water or the Vapour any augmentation of Temp[r] by its Ingress must have passed into a latent State.

— a Quantity of water was heated to 400 in Papins Digester — it was removed from the fire — and the safety valve opened — one third of the whole was converted into Vapour and both the Water & Vapour were reduced in an Instant to 212° and the whole of that plus Calorie which had been raised it to 400 — ie 188 degrees immediately disappeared or became latent.

Mr Crawford added to water at 212 a Quantity of Iron filings of a much higher temp[r] — a considerable Quantity of the water immediately evaporated but of this none attained a Temp[r] of 212.

— It was first remarked by Mr Th. Mr Boyle that when water or alkohol is made to boil in an exhausted receiver their Temp[r] lowers very rapidly as that Calorie which first raised its Temp[r] to the degree of Vaporation passes into the Vapour.

Exp. Demonstrating this — a Cylinder with a small portion of Water immersed into another Cylinder containing Ether & both placed under the receiver of an exhausted air pump — on the boiling of the Ether for a short time the water

~~heat of water~~ is frozen

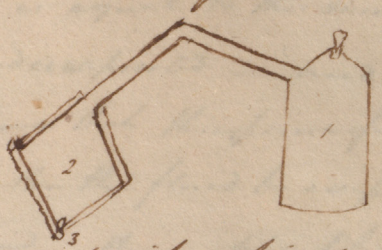
This heat was supposed by Dr Black to combine with the fluid & thereby cause its expansion into Steam — It has been hence called combined Caloric

It is well known that the human body will bear without injury a heat of 230 or more degrees but if Steam of this Temp of 212 falls on any Part being immediately condensed & parting with that latent Caloric wh it received on being converted into Steam it scalds the Part most severely

So if 4½ of Water be converted into Steam in a common distilling Apparatus — and it be condensed in a refrigeratory containing 7½ Pounds of water and runs out at ye end of ye refrigeratory at Temp. 62 — provided it had lost no more Caloric than it appears to have done from ye Diminution of its Temp the water in the refrigeratory ought to have gained only 2. degrees of Temp but in reality it gains 15. so that the Increase of the Temp of ye water in ye refrigeratory is as great as it wd have been — if the Steam possessing no latent Caloric had entered the refrigeratory at 162 and passed from this Temp to 62°

W Watt of Birmingham knowing that water wd

wd operate at a much less Temp.e in Vacuo wished to apply this principle to an economical Purpose in the Construction of Steam Engines and the following experiments did not answer his expectations in this particular they tend to light a very important & curious fact



A quantity of water being put into a tin Vessel (1) it was joined by an inflected tube to a Refrigerator (2) & the valve (3) being open the whole apparatus was filled with Steam and while the Water in the vessel (1) was boiling very rapidly the valve (3) suddenly stopped the vapour being then condensed it is evident that a vacuum wd be formed over the water in the Vessel (1) & accordingly it began to boil a considerable time at a Temp.e of about 112 — But Mr Watt was disappointed in finding that the quantity of Caloric given out to the water in the refrigeratory was as great as if it had not been boild in vacuo — proving that the Steam or vapour is always of the same Temp.e however different the Tem.e of the fluid may be from wh it is formed Thus if the water be 212 it imbibes a portion of caloric

equal to 950 degrees heat to convert it into steam, if it be 212 it requires or absorbes 1050 to convert into Steam

and 212 + 950 = 1162 :: 112 + 1060 = 1162

So that the <u>plus latent</u> heat it receives in evaporating in vacuo is equal to the minus sensible heat of the fluid evaporated — and from hence it will appear that the expence of fuel + Calorie will be equal whether the fluid be evaporated in vacuo or not — as the quantity of latent heat wch enters the vapour increases as the pressure on the fluid decreases

The effect of Pressure on Steam itself is to press out the latent heat in a sensible form & thus augment the Temp. This may be illustrated by half filling a Cylinder closed at one extremity with water & steam Then with an air tight Piston force down the vapour as much as possible mixing the Cylinder at the same time in cold water

In consequence of this law of nature that every body imbibes a large quantity of Calorie in entering into a vaporific form we are exempted from the form of elevating their Temp near to their vaporific point — but beyond they wd evaporate & otherwise they wd have done by a sudden explosion

Dr Black believed that a body became vaporous
in consequence of the heat combined with it
& that to this combination it owed its elasti-
city — he imagined that fluids were compounds
of their Bases and of Caloric and that earth
gases were compounds of the same bases with
a large portion of Caloric — and in the return
of a body to a fixed state Dr Black believed that
that the body became condensed in consequence
of the extrication of the latent Caloric
On the other hand Dr Irwin imagined that when Bodies
arrive at a certain point they evaporate &
their capacity is immediately changed and
that so large a portion of caloric is absorbed to
satisfy this increased capacity &
So that Dr Black considers and Comm Mr
Irwin considers and effect & vice versa
Dr Crawford ~~attributes~~ imputes the capacity of water to
that of Steam to be as 1000 to 1550
I cannot dismiss this Subject without saying
something of the uses to which Steam is
appropriated depending on its mechanical
or chemical properties or both.
Steam is principally employed as a moving power
in that most useful instrument the Steam Engine

this was first invented by the Marquis of Worcester
greatly improved by Mr Savary Capt. Savery &
Mr Smeaton & a great degree of Perfection by Mr
Watt of Birmingham
The object was by means of the mechanical
& chemical properties of Steam to give an
oscillatory motion to a beam — wch is worked
fitted to so great a degree of nicety that the
beam will keep time with the best regulated
clock for a week together without a minutes
variation: and the Steam extricated by the Com-
bustion of one pound of water is capable sufficient
to raise 1100 or 1200 24 feet high
Description of the Steam Engine
a Steam Engine whose Cylinder is of 60 Inches
Diameter exerts a force equal to that of 200
horses besides that its operation is constant
Steam is also a very convenient vehicle for
transporting Caloric to any distance if the pipes
for its conveyance be covered with a non-conducting
matter but it cannot raise the Temperature
above 212. or at that temperature it ceases to be
condensed — By Steam apartments are heated or hot Baths in them apart-
ments by an external fire — and many useful

Purposes are and to Dyers who can heat 20
water from one fire without help so much wear
& tear of Vessels — to the Cook who can dress
for a large Number of Persons by Steam in a very short
time, to the Vinegar makers who apply heat
by a circular tube going round the bottom of the
Vessels &c &c Stimulus of great use to
Bleachers in drying their cloths — and drying
of Gunpowder &c

When any substance assumes the form of a
Gas or permanently elastic fluid its Capacity
for Caloric is greatly increased — but the Gases
have to present an Attraction for
Caloric that they cannot be made to part
from it either by compression or reduction
of temperature either of which would be sufficient
to cause the vaporous fluid to part from
its Caloric & The Gases combine as much
Caloric as Vapours in passing into the aerial form
they give out much less in passing from a high
to a low temp as they cannot be condensed,
but they may be separated from their Caloric
by Chemical Combination

Gases sink in Temp. when expanded and [illegible] when compressed hence if a forcible stream of air be directed to ye bulb of a Thermometer it will ascend by two or three degrees

VII. A Quantity of Caloric enters into all Gases and is essential to their existence

If potassa be mixed with nitric acid the Temp of ye mixture rises — but if the Carbonate of Potash be employed it sinks several degrees in consequence of ye carbonic Gas having absorbed and carried off ye caloric —

Every Variation of Heat real or apparent taking Place in consequence of a change in any System of substances reappears in an inverse order on the return of ye Substance to its former state

(Spontaneous Evaporation) That dissipation of its parts wh many substances suffer by exposure to ye Air by which a body decreases & vanishes till ye whole disappears

~~Hence~~ Solids as well as Fluids susceptible of this Change — as Ice Camphor ammonia muriata &c — All bodies not equally affected by this exposure, thus ether alkohol & water

evaporate very speedily — Quicksilver and express'd Oil with great difficulty & Gold Marble &c not at all

Substances w.ch boil at the lowest Tempera- are those which evaporate with the greatest Celerity

Spontaneous Evap: does not take place with that Emotion w.ch accompanies Ebullition but is imperceptible — It takes place only when the evap: Substance is in contact with the Air and the celerity of d. process is cæt par: in proportion to ye extent of surface exposed to d ~~ext~~ air

A frequent or constant renewal of d circumambient air greatly expedites spont Evap: The effects of a current of air in drying a washed Room or of a windy day in drying wet corn or dirty roads is well known

Precise Experiments have proved that a certain Quantity only of any body can be received by a given bulk of Air w.ch bulk of Air is then said to be saturated — the more distant it is from the point of saturation d more rapidly does it imbibe these vaporous exhalations

Spontaneous Evaporat is increased by an increase of Temp — and this Effect is proportionably

greater than in the Ratio of the Increment of Temp.
applied — Consequently the Air is saturated with
a much smaller quantity of Vapor at a low than
at a high Temp. — e.g. The Vapor of Camphor
w.ch was retained by the air during the heat of
the day is deposited on the sides of the bottles
when the Temp. becomes cooler — On the same
principle it is that the Air under the Tent
in the Evening the Vapor of whose deposits it in
the form of Dew — Hence too arises the moisture
found inside of a Vessel containing cold liq.
or moisture on the inside of the windows of
a warm apartment warmer than the external
air —

During Evaporat.n Caloric is absorbed & energy
cold produced — — Evapora.n of Water from
bulb of a Thermom.r — Evap.n of Ether
&c in the Last & best Ind.a Apartm.ts are cooled
by suspending in the Latticed Windows moistened
grass Tatties and their liquors are cooled by
exposing them to a brisk current of warm
dry air in a vessel with a wide surface
enclosed in a woolen bag.

In Bengal Ice is obtained by exposing
Water during the Night in Shallow Vessels with a very

porous texture & wide surface placed in Bamboo
Canes & in these the desired Effect is produced
tho the Temp of ye Air ~~[illegible]~~ may not descend
within some degrees of ye freezing Point
a greater effect is produced by more volatile
Substances - Cavallo reduced ye Temp to 3°
in ye bulb of a Thermr by ye Evap: of S^{t} xx of
ether — There is a certain maximum of
cold produced by ye Evap: of each respective body
at a given Temp
The quantity of caloric absorbed during spontan
Evap: has not been ascertained -
This Process is ascribed to two different Causes
by different Philosophers
- 1 The Action of Caloric — The Solvent Property
of ye Air — D. Hope seems to yield to ye latter
The Air be supposed to act as a Solvent in
which Caloric is a great auxiliary and the
action of the air to depend on a Chemical attrac
tion between its Particles & those of the ~~water~~ fluid
- If a vaporable body be freed from the Pressure
of the Atmosphere a vapor arises the Elasticity
of wh is in proportion to its Volatility & if this
Vapor be drawn off - another portion is evapd:
But this process is different from that of Spont.

Evaporation — The vapor in this Case arises from the Caloric that combines with it — is elastic and condensible

There is an evident chem Attract between Water and Air & they are reciprocally contained in each other — The too is of the nature of an elastic Atraction for water quits Air to combine with some other bodies & quits the certain other bodies to unite with Air The Phenomena of Spont Evapor: similar to those of Solution — Thus a fluid evaporated evaporates disappears — and unites with the Air into an homogeneous fluid —

This Solution too like all Others is assisted by heat and retarded by cold — if the fluid require a higher temp for its solution it is depositted on reducing the Temp: — The Solvent admits of Saturation with the fluid & and the power is promoted by agitation

Elastic fluid Bodies evaporate more speedily than others & hence (it may be proper to remark) a Theory has originated that Evaporation depend on Electric fluid — but that has been clearly does not deprive more than evap: fluid than air that has not been electrified — but there are

and many chemical actions in w.ch the elastic
fluid is not excited or a fluid obviously analogous
the Galvanic
The Evaporation particularly of Water is a
Subject of great importance and forms
the Basis of Meteorology
Only a certain Quantity of Water can be dissolved
by a given Quantity of Air at the same Temperature
& the Increment of the solvent Power of the Air
is according to Saussure (Chaussier 27) proportional
to the increment of Temp.e so that if Water
at 40 dissolved a certain portion & the plus qual
it dissolved at 50. were equal say to 2. the
additional Quantity it wd dissolve at 60. wd be
2 more or 4. at 70 2 more or 6. &c
But Dr Hutton contends from experiment that
the solvent Power of the air increased in a much
greater ratio than the proportion of increase of
Temp.e — Thus if an increase of Temp.e of 5. from
40. to 50. dissolve a portion equal to 2 — the increase
of 10 more degrees of Temp.e from 50 to 60° would
dissolve a portion equal to 2. 5. 3. & 70° 4 &c
Mr Lesley says that the Quantity of Water w.ch Air
dissolves is doubled by every increase of 10 Degrees
of Temperature

Mr Lambert concludes that a cubic foot of air will dissolve 380 grains of water but with much greater appearance of accuracy and probability computes that a cubic foot of air in passing from extreme dryness to saturation at the temperature of 85° — 6 7/10 grains of water

The air when saturated with water expands both for bulk less but w.t for w.t more than before it occupies 1/54th more space but it gains only 1/74th more w.t and consequently its specific grav.y is diminished — Therefore when air in contact with the Earth becomes saturated with water it ascends — and on a reduction of its Temp.e being unable to retain the same quantity of water it is deposited & formed into clouds or falls in rain But this often occurs when the average temp.e of the air suffers no reduction & this is a Phenomenon w.ch Dr Hutton has most ingeniously explained on a principle before mentioned viz that the solvent power of air increases in a greater ratio than the increase of its Temp.e — for when when two portions or strata of air of different Temp.es are mixed together if the warmer stratum be nearly saturated with moisture it must deposit this moisture because —

the solvent Power it loses in being reduced to a
mean Temp is greater than the addition of Solv.t
Power which the Stratum of ~~Air~~ lower Temp.
acquires — so that the portion of moisture
wh they could retain when both were separate
they can retain no longer when blended —
and the Quantity of Water deposited must
be in proportion to this loss of Solvent Power
Hence the frequency of Rain in the neighbour
hood of Mountains in the Channel &c Winds
— On the same Principle the Phenomena
for the appearance of smoke — of vapour
over the breath of a living animal — & of the
vapour which ascends from water over which
Ice has been formed when the Ice is broken
— According to this System it will appear that
M Saussure was in an error for had his doc
trines been just — along with a mean of Temp.
a mean of solvent Power would also have been
produced —
When the moisture is separated from the air it still
remains suspended in the form of clouds
This supposes that the separated Particles
must be of the same specific gravity
with the suspending medium — and it is

supposed that the meteors exist in a state of
vesicular particles filled with some light &
mobile ~~fluid~~ body — it has been suggested
that this is Electricity — These vesicles are esti-
mated to measure ~~2000~~ 1/3600 of an Inch —
Arguments in support of this opinion are that
a luminous body seen thro a vapour presents
a very diff. appearance from it
wd do if there were mere atoms — This may
be seen on a surface of hot coffee &c. when
the vesicular particles are seen trembling abt
in a manner only explicable with this supposi-
tion — From this explan. of the Cause of Rain & Snow
it will easily be seen why their descent is accom-
panied with an increase of warmth —
But from Mr. Wilson's experiments it appears
that Rain Frost &c. produce an remarkable
exception to this — Thus in a serene cold &
clear air if a Thermometer be placed during
the night on snow or sand or any rough body (as it
has a greater attract. for Rain Frost &c. than a smooth
one) it will fall several degrees in some instances
12° below the Temp. indicated by another Therm. at
the height of a few inches above ~~the surface~~
it — but in a windy or cloudy sky this experiment

In order to ascertain the dryness or humidity of the Atmosphere an Instrument has been contrived called the Hygrometer, but this is much less perfect than the Thermometer or Barometer

It does not of itself determine the actual Quant. of humid.y in the Atmosphere — but that degree of humid.y which is separated from it — Thus the air is said to be moist which is disposed to part with its late moisture or dry when it is disposed to receive more — a moist air in a Winter may contain much less water in reality than a dry air in the Summer — By a long series of exp.s calculated & reduced with a Hygrom.r & Thermometer combined the actual Quantity of Humid.y in a given air may be known — but this is of less importance to mean than of moisture or dryness of the air — and there are 3 ways of determining this — 1.st by exposing some substance capable of absorbing the moisture of the air and observing from some change produced in its weight form or density

Basis or principle on which these are founded is that there are certain substances which

have a greater attract for Humid than the air of the Atmosphere — as sulphuric Acid or Muriate of Lime — and these are sometimes used to calculate ye Humid of the air by the increase of their weight but this is a tedious process — a change in ye Density &c is more easily ascertained thus it is well known that Moisture causes Vegetable fibres to contract ~~an~~ animal fibres to elongate — the best Hygrometer on this principle is that of Saussure — made with a human Hair boild to purify from animal oil in a Solut of Potash (℔ vj to ℥j) Kept tense by a Ball and its numerous varia: shewn by an index (turning on an axis) whose range is equal divd into 100 degrees from ye greatest dryness to ye greatest degree of moisture in the air — — a question naturally presents will Hairs be always uniform in ye contracting power — this is doubtful and ye Lect impeaches ye accuracy of this Hygrometer proposing in ye place of Hair a shaving of whalebone wh seems liable to ye same objections

The 2d mode of determining is on this principle that the greater the humid of the

(1) I suspect that this is not correctly transmitted — the moisture of the air is measured I imagine by the quantity of additional moisture it imbibes and this by the degree of cold produced — for the capacity is to vary according to various circumstances but the degree of Cold as Mr. Leslie has shewn is to be uniformly the same

the less rapidly does it receive an addition of moisture &c — a Grain of a fluid is expos'd to air and the calculation is formed from the rapid.ty with w.ch it evaporates — D.r Lesley Hygrometer constructed on this principle and he judges of the rapid.ty of Evap. by the degree of cold produced w.ch is measured by ~~means~~ the ascent of alkohol in an air thermometer

The 3.d mode of measuring d.e humid.ty of the atmos consists in observing the Quantity of moisture deposited by the air on a certain degree of reduction in it. Temp.

Ignition or Incandescence by which is meant that state to which bodies are brought when their Temp.e is elevated to a certain pitch emitting light & heat — it differs from Combustion as it does not imply any chemical change — The many bodies which undergo during Combustion — It has been taken for granted that the temp.e at w.ch all bodies become incandescent is the same — and the more intense of increase of their Temp.e the more luminous do they become, This however must be a

(1) The Divisions of the quarter degrees of heat into dull red — bright red dull white & bright white empirically according to W. Wedgwood's scale equal to 20000° of Fahrenheit

(2) It was then found that transparent bodies in approaching to incandescence became opaque

very uncertain criterion of the degree of Temp
as the point at wch it begins may appear
different as seen by the eyes of different People
or thro more or less luminous media (1)
(2) This seems the most proper place to take
some notice of the connection between heat
and light — If a body is heated to a cer-
tain degree it in all Cases becomes lumi-
nous — if the body wch communicated its
caloric were in a luminous state it might
be conceived that the light was communica-
ted at the same time with the Caloric but
the effect is the same if a bar of Iron be
made incandescent by Percussion or Friction
This connection between light and heat has
given rise to a great many Exp & Observa:
and here permit me to say a word or two
on the subject of light wch every day becomes
more & more connected with chemical en-
quiries — Its nature is undetermined —
whether it be a distinct species of matter or
whether it consist in the oscillatory motion of
something extended thro universal space
Its Velocity is inconceivable it flies from the

as was calculated by the appearance of the Satellites of Jupiter after emerging from his Disk

over a distance of 95 millions of miles in
8' minutes & 13" flies 3 times to America
& back in the quarter of a second (a)
It rebounds from polished opaque bodies and the Angle
of reflection is equal to the Angle of Incidence
— it is refracted in divergent rays when reflected
from a convex surface & in converging rays
when reflected from a concave surface
In passing from a dense to a rarer medium
or from a rare to a denser med: it is refracted
& the degree of refraction differs in proportion
to the density of the medias — Inflammable subst
have a greater power of refraction than incombustibles — The rays in passing from a con
vex lens to a rarer ~~body~~ medium & in passing from
a concave lens to a rarer ~~bo~~ medium
The white rays consist of seven primary colors
Red orange Yellow green blue indigo and violet
wch are separable according ~~to their different~~
~~ity~~ to the order in which they are brought
the red being least & the violet most refrangible
and if all them are mixed in a proper proportion a
perfect white is produced

When rays of light or heat pass thro the air they
pass into and heat an opaque Spirit but they do
not heat the intervening air — & the heat in
this Case is said to pass by radiation —
Proof of this if a person stands before a large
fire he feels a great degree of warmth and if
a person standing on the right hand blows
Air towards another person on the left
hand of the fire the latter feels no increase nor
does the person standing in the middle perceive
any diminution of heat
Mr Lambert found that the effect of Radiation
on a Thermometer decreased in the Square ratio
of the distance from the heating cause
Exp: demonstrating this radiating Property — by
placing an incandescent body in the focus of a Sect
of Sphere 9 Inches radius 12 diameter & a thermometer in the focus of another
parallel Sphere at the distance of 14 feet
— Thermometer ind. a considd increase of Temp
— Phosphorus ignited by the same means —
not only bodies in a state of luminous incandescence
but boiling water produces a similar effect —
the foci of the reflecting Spheres being
about 4 feet from each other — on reversing
the Sphere or else removing the Thermometer a

a very little from the Fires the effect ceases
It hence appears that this radiation is susceptible of reflection & refraction like light

These principles may be reduced to very useful purposes as Count Rumford has proved in the Construction of Fire Places — It that is is evident heat passes away in two different modes 1st by communication this passes up the Chimney principally and does not any good to the room 2d by Radiation & therefore the fire places shd so made that as many of the calorific rays as possible may be reflected into the Room — hence the Sides of the shd make an angle of about 135 or 140 with the back and shd consist of white tiles or stones — and ⅓ of full with heat the room in an equal degree as a usual quantity when the fire place is made in the usual way

D. Herschel has instituted a great many exps to determine whether the luminous and the calorific rays are reflected or refracted in an equal degree in passing thro a medium and he has tried with a great number of Media — The result of his experiments seems strongly to favour the conclusion that they are distinct from each other

Schuckburgh found that a Plate of Glass reflected
of the luminous but none of the Calorific rays
If was near the truth as may be proved in the
Degree by the easy experiment of holding first
a polished tin plate so that the rays of fire
may be reflected & d Check and afterwards
a glass mirror and in d latter case a much
less degree of heat will be perceived — But Schuck
according to Herschel was not quite correct
I shall mention a few of his results
of 1000 Parts of rays rays if you please

	luminous	calorific	invisible rays of Heat
Clear white flint Glass intercepted	34	750	533
Crown Glass	203	722	783
Tale	90	703	615
Bank red Glass	999 9/10	573	630

D. Herschel has shown that in d sunbeams the
calorific and luminous rays are distinct
In his experiments a beam is made to pass thro a
prism — and thus divided into d prismatic Spectrum
& he found that the rays of different Colors possessed
very different calorific Power D. Herschel was
led to this discovery by looking thro different co-
loured glasses at d sun and he found that when
a red glass & red ink some blue colors was employed
the heat was very painful to the Eye and he

advises for this purposes blue colored glass as ye best

But the most important discovery is that there are certain invisible rays at an inch or more ~~distant~~ below the red rays which are very powerfully calorific Dr. Robinson says that these extend to ye distance of 2½ inches from ye confines radii of ye red ray — it must be evident from the position that these invisible rays must be have less refrangibility than the red or luminous rays — Mr. Lesley has wth some unwarrantable acrimony denied these facts but the experiments of Mr. Herschel deserve no small share of confidence he found these invisible rays susceptible of refraction reflection & collection into a focus — but as they are more powerfully calorific & less ~~refrangibility~~ refrangible it naturally occurred that the focus of the greatest heat when ye rays are collected by a lens must be something beyond ye focus of the greatest light and this Dr. Herschell from an experiment with sealing concludes to be really the case

Dr. Herschell endeavored but in vain to render these rays visible of 1000 Parts of these rays he concludes from experimts that clear flint glass intercepts none Dark red glass none Green Glass 500 Blue 187 Bluish green 860.

It is much to be wished that these experiments so perplexing and so delicate sh.d be repeated —

Dr. Herschel allows that light is in no degree calorific but becomes apparently so in consequence of the invisible calorific rays intermixed with it. —

It must appear that these invis: calorific rays have a greater range of refrangibility than the luminous rays — Perhaps Dr. Herschels exp may throw some light on this circumstance that no degree of heat can be collected from lunar rays. Does the moon reflect its luminous & absorb its calorific

Lambert Saussure & Pictet considered this Heat ~~as~~ or invisible emanation ~~calorific ior~~ as distinct radiant ~~substance~~ Caloric

Dr. Hutton maintains that it is different from Caloric not at all according with ~~the laws~~ those laws of communication by wh.ch we know ~~light~~ caloric to be governed but agreeing with the properties of light in every respect but one — luminousness

Dr. Hutton conceived that ~~all~~ the luminous rays became calorific when intercepted — Dr. Herschel is of a contrary as before stated — Perhaps this invisible emanation is different both from light and heat & a link connecting both —

Very different opinions have been entertained as to the nature of light and its discrepance in more

Incandescence from heat but we have not data sufficient to establish any of these

From ye experim^{t} yesterday exhibited of ye warm water it appears that ~~all bodies in nature~~ there is a radiant emanation of heat from all warm bodies in — and the Photometer of Mr. Lesley (consisting of two very delicate thermometers one with a black — the other with a resplend^{t}. ball is in reality a measure of the luminous rays and invisible rays combined

It is important to enquire whether the emanation in the same body be proportion'd to ye increase or decrease of Temp —

C^{t} Rumford remarks that stones do transmit through not more of ye calorific rays than some other Substances at ye same degree of Incandescence as metals & even ye coals themselves

It is also of importance to enquire whether a heated body cools in proportion to ye Caloric communicated or radiant from it or both. — If a hot body is placed in vacuo it must grow cool by radiation if in sand by communicat. so that it appears capable of changing its mode of giving out its caloric

It is remarkable that not only heat radiates but Cold seems to do so

Exp Metalic reflectors 5 feet distant a Mixture

of Ice and Cold Nitrat in a Flask in one Jar
and a very sensible Thermometer in the Air
Thermometer rises — on reversing the Vessel
Ice sinks — rises again on reflowing it
a certain fact — Cold is used as a negative
Quality and to talk of its radiat is absurd
Perhaps the order may be reversed that I may
radiate from the Thermometer to the cold Body
Air — Solutions of this Phenomenon are
various and all unsatisfactory

Inflammation & Combustion has been mentioned
as a fifth Effect of Caloric — but of this we
shall take notice when treating of Inflammable
bodies — I shall now conclude this Part of
the subject with the following Table

	Wedgwd.	Fahrnt
Red Heat of Iron in daylight	0	1077
Enamel Colours burn in	6	1857
Brass melts	21	3807
Silver melts	28	4717
Gold melts	32	5237
Delft ware ~~burnt in~~ baked in	41	6407
Cream coloured ware baked in	86	12.277
Plate Glass Furnace	124	17.197
Pig Iron melted at	150	20.577
Nankin Porcelain softened at	160	21.877

91 the degree of Cold produced by Mr Walker
89 at Hudsons Bay by Mr Hub 84
50 natural cold at Hudsons Bay
39½ freezing of Quicksilver
14 Cold obtained at Glasgow
7 Brandy freezes
0 mixture of Ice & Snow & Salt
20 Strong brine freezes
27 Vinegar freezes
32 Frost. Human blood freezes at 25. Milk at 30
84 Summer Heat
75 Sultry Heat
98 Blood Heat in from 98 to 100
107 Fever Heat in from 104 to 112
142 Bees wax melts
158 Albumen & Serum of Blood coagulates
174 alkohol boils
212 Boiling Point and at 210 water saturated with salt boils
600 Tin melts
460 Bismuth melts
548 Nitrolic Acid boils
560 oil of Turpentine boils
580 Lead melts
600 Mercury boils
650 Iron begins to shine
750 Iron shines
1200 Iron shines in day light
3777 Zinc of W. Pyrometer common

II Chemical Action

By chemical action I mean that action which takes place between different Bodies when the minute particles of one body are applied to the minute Particles of the other body of which opposing the effect in consequence is that certain parts of one body unite with certain parts of the other body forming a result which is uniform & homogeneous to the minutest atom into which it can be divided and which differs in change or separation — spontaneously or by mechanical Purpose —

Eg with Potash & oil

All Bodies in Nature are not capable of this chem. act: on each other —

Eg example Water and Sand

But it takes place in a vast variety of Substances and generally between those bodies most dissimilar from each other

Chemical Action takes place only between the constituent Parts of bodies

Whatever contributes to reduce bodies to minute parts favors chemical action — by bringing the particles into a greater proximity to each

them and by destroying cohesive attraction
— Bodies mutually divided by communicating
by Solution — 24 gr. of Nitrate of Silver that
is one of silver & one of Nitric acid dissolved in 10000
drops of water — & the Silver rendered visible by a drop
of muriatic Acid in a smaller part. say the [redacted]
1000th Part of a drop then this grain of silver is divided
& continues visible after it is divided into 10000 000
of parts —
Chemical Action happens only between dissimilar
parts — I do not say the ultimate molecules
for if there are ultimately dissimilar — no do I
mean the ultimate elementary principles —
for in the Instance before us in chemical Action took
place between the Water and the Nitrate of Silver but
the latter is a compound body and every minute
integrant Part of it is a compound
Mechanical Pressure may favor the approximation
and therefore the chemical union of bodies as Solution
and Crystallization
It is necessary generally speaking in order to chemical
Attraction between two of the bodies to both be in a
fluid State (but there are exceptions) and this fluidity
is effected by the admixture of fluid Substances —
by fusion or by uniting the substance in to gas

Cold retards or represses and Heat increases Chemical action but this is true only to a certain extent

Exp.t with Nitric Acid Diluted & Alkohol — heated a candle is bro.t to ye mouth of ye vessel — the flame is excited on reduction of Temp this ceases

When chemical action goes on too rapidly at the ordinary temp it is sometimes necessary to repress it by snow or frigorific mixtures

Those bodies which cannot be resolved are called Elements all others are called compound bodies —

When two simple bodies are mixed having a Chem attraction for each other, the invariable effect is that the particles unite with each other forming a third substance homogeneous to the minutest particle — which does not separate spontaneously or by mechanical means This is called Synthesis

It is a common error that the third body so form: is a medium between the two cons~~isting~~tituent parts — but this is a mistake, ye result is perfectly different

It differs in medical Qualities or effects on ye human stomach — Potash & Vitriolic Acid — most acrid of bodies unite into a mild neutral Salt Sulph. of Potash

— It differs in Smell   Sulphuret of Potash

It differs in Color   yellow & red oxyd of Lead

It differs in regard to the effects of Heat and of

Chemical Substances

In consequence of this law that the compound bodies possess properties entirely new it is that Nature presents such a rich variety of different Substances — for as the primary Elements of matter are probably very few in number — such a variety could not subsist if the union of two simple bodies produced a third possessed of Qualities.

Mixture and Union are often confounded — The one is a mechanical the other a chemical Effect. In a mixture the parts are intermingled but the principles are not changed no third body of an homogeneous nature is produced. — Thus if sand and Quicksilver are mixed together — no chemical union results. When two or more substances are compounded or enter into a State of Combination they alter their form of existence and each may be made by proper processes to resume its prior former Existence — This is called Analysis That form of chemical Combination with which we are perhaps most familiar is Solution — Alkohol and Camphr. Salt and Water the dissolving body is called the Solvent or Menstruum

the body dissolved is sometimes called a Solution
Solution must be distinguished from Diffusion
clay may be diffused in water but no chemical So-
lution of the clay takes place the whole does not be-
come an homogeneous fluid - but the parts both of
the clay and of the water exist in a separate state
& on standing spontaneously separate
Sometimes on mixing together a solid and
a fluid - a brisk perturbation & chemical Com-
bination may take place and yet there may be
no Solution Example Nitric Acid and Tin -
Result a dry powder
A change of Temp generally takes place in a
chemical Combination
When both the combining Substances are fluid
there is generally an increase of Temperature
Exp: Acid SulPh: & Water ää ap. warm water
made to boil in the mixture - Eggs have been
boiled by the same means
D: Black explains this as arising from an extri-
cation of latent heat - Lavoisier & De Place
disengagement Crawford
D: Irvine ascribes it as the Effect of a diminution
of Capacity for heat in one or both the Bodies mixed
Others suppose it to be caused by a diminution
of the Attraction for caloric in the Substances thus
combined

In some Instances of Chemical Combination the Effect is diametrically opposite & a Diminution of the Temp is produced — Salt in Water Nitrate of Ammoniac Potash and Muriate of Ammonia Dissolved in Water. and another portion of Water caused to freeze in the mixture This also is explained in three Different ways — by the absorption of latent heat when the Solid is passing into a fluid form — by an increase of Capacity during Solution and by increased attraction for Caloric

In some Cases of Combination there is little or no alteration in Temp tho both the substances entering into the composition undergo a great change of Temp abstractedly considered.

Thus if Sulphuric Acid and Ice be mixed — the Solution of the Ice is a powerful cold making and the Combination with Sulphuric Acid a powerful heat making Cause and these counteract each other Chemical Combination is attended with a Diminution of bulk and consequently an increase of Density — Thus it is a Circumstance very well known that if 50 Gallons of strong Spirit and 50 Gallons of water be mixed together the Compound will not be more than 97½ Gallons — This is

Attached to the particles of the one substance,
penetrating into the Particles of the other, Exp.
with acid Sulp. & water
Substances entering into Chemical Combination
unite in certain definite proportions and cannot
be made to unite in greater Proportions —
Thus water will dissolve only a definite quantity
of Salt — and if more than this is added it is said to
be saturated
Saturation has been said to be of two Kinds — Simple, when one of the substances may be varied in its
proportions to Saturation — as any proportion of
Salt e.g. may be dissolved in a given quantity of
water — provided that it be not more than the quantity sufficient to
saturate the water — 2d Reciprocal or mutual
one when both substances unite in certain definite quantities — Exp: Selenite dissolved —
on dropping in Sulphuric acid — this Portion of the acid
unites with a certain definite portion of the Earth and
is precipitated — on dropping in Alkali more of the
Acid this two unites with its definite quantity
& falls to the bottom &c &c
It sometimes happens that one substance will
unite with another chemically in 2 or even 3 or 4
different and yet definite proportions
Thus Tartarous acid uniting with Potash

in a certain definite proportion forms
the Soluble Tartar or Tartrite of Potash in
a certain definite but larger portion of the
acid & added A forms Cream of Tartar
or acidulous Tartrite of Potash — and if
more of the Tartarous Acid & added a third new
acid will be formed but in which both the ingredients
will exist in definite Proportions
So Acet and Oxygenic acids unite in 4 different
Proportions yet all are definite proportions
Guyton de Morveau is of Opinion that Saturation
is always reciprocal, and those Instances
which wd lead us to suppose Menstrua — such
e.g. as that of Salt and Water just mentioned
he explains by imagining that as soon as the
mutual action has taken place the Compound
that is formed acts as a Simple and then
unites as such with one of its component
Parts — i.e the Salt & Water uniting in defined
proportions form a defined Compound w.th acts
as a Simple in uniting with the remaining
or superfluous part of the water
We have yet to learn the Law of Proport.
in w.h the Particles of one Body unite with those of
the Other — for tho we may discover their powers

proportions of each yet we are entirely ignorant of the comparative magnitude or number of the particles and why they are always equal whether the single particle of one body may require one or two or more particles for its saturation

The Phenomena Attendant a Combination vary considerably according to the form of the substance employed whether solid — fluid or gaseous 2dly according to the qualities of the compound exist it is fixed or volatile soluble or insoluble colorless or possessing colour &c &c

Such are the facts with regard to the Combinations of bodies termed Elements but there are only few compared with the Compounds

If two bodies unite chemically of which one is a simple & the other a Compound Basis consisting of two ingredients — B may act as a simple body and unite as such with A. forming a compound of three ingredients — and such a Combination will be attended with a change of Temp and of Bulk as in the case of simple combination but it more commonly happens otherwise — Thus if a simple body A. act chemically on a comp. body — consisting of B. C. it generally happens that A unites with B and C is thrown out Thus eg.

If I pour a solution of Potash into a solution of lime in muriatic acid or muriate of lime — the Potash unites with the Muriatic Acid and the lime is thrown out — This is called Analysis

When two compound substances act chemically on each other sometimes they unite by pure Synthesis — Thus if Sulphuric Acid wch is a compound of Sulphur & Oxygen — be added to and Chemically on ammoniac wch is a compound of Hydrogen and Azot. They unite and produce Sulphate of Ammonia, and in this case it rarely happens that when 4 bodies unite Chemically the ingredients do not be combined together at once but two of them unite first together and then the other two unite — and the substances thus compounded enter into Combination

But it more rarely happens that they do combine all together but interchange each an ingredient thus if a compound body A. B be mixed with another compound body C. D and they act on each other it commonly happens that A. having B unites with D. and B unites with C forming A. D and B. C. or forming A. C & B. D

There are two modes of Analysis — 1st by the Vaporation of Temp — and generally by an elevation of Temp thus if Sulphuric Acid and water be united

and the Temp. sufficiently elevated, the water being
more volatile with quick of Muriatic Acid — but in
this Case the attraction between the water & the Acid
are so very strong that although the vaporific point
of water be no more than 112° Fr requires in this
experiment not much less than a Temp. of 550°
and Instances of Analysis of this kind are by no
means unfrequently numerous — Muriatic
Acid tho a very volatile substance when com-
bined with Lime cannot be made to quit it by
any elevation of Temp.
In other Instances Analysis is produced by a
reduction of Temp. — as Salts are brought to an
equal or crystallize by the reduction of Temp.
The 2d & more general mode of analysis is by the
addition of a third substance with wh one of the
ingredients has a greater disposition to unite than
it has to remain in union with the other ingred.
of the Compound
If it is required to obtain one of the component ingre-
dients separately of this new compound separately
a 4th substance must be added with wh the other
ingredient of this new Compound has a greater dis-
position to unite than to remain in Combination
with that ingredient which we wish to obtain separate

Thus if e.g. if to a Compound of Camphor and
Alkohol I add a portion of water — the Camphor
is separated — as Alkohol has a greater attraction
& disposition to unite with water than with Camphor
Thus if I wish to obtain Alkohol separate I
add lime or muriate and for water having
a greater attraction than for Alkohol the lime
separate Alkohol is separated

Deposit Muriate of lime — add Potash — lime
separated add Sulphuric acid
muriatic acid separated & the Sulphate of lime being
insoluble in ~~menstruum~~ fluid falls to the bottom

These Analyses occur very often in Chemistry & frequently
at the end of chemical Processes — & frequently it
occurs that both the substance disengaged & the substance
new Compound formed are either insoluble & so
both fall to the bottom or both soluble and remain
in the fluid the newly existing in a separated state

Hence it appears that in Chemical Combination
the essential Constitution of the body is not changed
but there is merely a change of properties & important circumstances

On many occasions it happens that a body compound
body cannot be separated by the addition of third simple
simple body but a compound body must be added and
thus two new Compounds are formed — and thus

having formed two new compounds — Either of the original constituent ingredients of the primary compound may be obtained separate by further analysis and by employing the means we have been now explaining Compound bodies may be separated in every Instance

While a Chemical Action may take place between one body and a great many Thus it almost invariably happens that its disposition to unite with each is in different degrees

Thus if you take a body X which has a disposition to unite with several other bodies a B C D E F and if to a mixture of A B C D E & F you add X in such quantity as is not more than sufficient to saturate any one of the Ingredients X will unite with A only — if A be wanting it will unite with B &c — Now further if X were previously united to F — if E be added it will quit F to unite with E Thus if D be added it will quit E to unite with D &c — Thus Nitric acid has a disposition to unite with Silver — but it will quit Silver to unite with Quicksilver Quicksilver to unite with Copper Copper to unite with Lead & Lead to unite with Iron

Experiments

Cause of these Phenomena — Nothing like Philosophical Inquiry had been adopted till the time of Bacon Newton

explaining the principles of Chemistry in of the Attraction Solution was then explained on a set of mechanical Principles & of particles of the solvent were supposed to be variously shaped like needles in water &c and even now we are apt to consider the solid as dissolved by the action of the Fluid whereas in reality the action is reciprocal — Sir Isaac Newton pointed out the tendency of bodies to approach each other & called it a System of attraction as a Phenomenon but of the cause of which he did not presume to offer a Conjecture The Species of attraction by which masses or substances are drawn together or towards each other in consequence of which Stones fall to the earth — or a line by each side of a mountain is drawn from & perpendicular by which the heavenly bodies are directed & governed in their orbits is termed Gravitation & the illustrious Philosopher proved that the force of this Species of attraction was as the mass of matter & inversely as the squares of the distances — Sir I. also observed the magnetic & Electric Species of attraction & he was hence led to infer a Chemical attraction between certain Solid & Fluid parts than between the particles of the solid itself and his opinions on this Subject form the basis of what we have to offer on the Subject —

That Species of attraction called Gravitation is universal extending to all bodies under all circumstances and at all distances
The magnetic & Electric attractions are particular
The attraction of adhesion is that by which matter masses of matter of the same or of a different nature are disposed to adhere — as eg. two Plates of Glass when brot into contact — hence the adhesion of fluids to solids — hence capillary attract. by which water rises in a Sponge or in the pores of a piece of Sugar, — This attraction tho greatly diminished by a small sensible distance is not entirely destroyed as may be proved by interposing a Silkworm's thread (the diameter of the fibres) between the plates of Glass — wh. tho thus separated to a minute distance will manifest some degree of adhesive attract.
The attraction of Cohesion is another Species caus'd by its different degree of force at the different gradations from a fluid to the most unpenetrable solid — In consequence of this Particles of Quicksilver or of water assume a globular form — and by this two globules of Quicksilver when brot into contact unite — This causes no change of composition or properties but merely increases the aggregate it has therefore been termed attract. of aggregation — This only takes place between Sub-

when Comb. into a certain degree of Propinquity &
its Laws are unknown

Chemical Attraction called also Attraction of
composition is that wh. takes place between the
certain dissimilar bodies - the particles of one by
separating, and uniting with the particles of a
certain body so as to form a third body different
from either in composition & properties

It is yet an undecided question whether all the
different Species of Attraction are not form different
modifications of a power impressed universally on
all bodies or r

† Reflexion I now proceed to enumerate the
principal axioms relative to Chemical Attrac-
tion or the laws as they are called by which
it is governed

1 This attract takes place only between bodies
which are of a different nature and among
certain of them only - It has been supposed
that there was some alliance or sensibility be-
tween bodies then combining and hence arose
the term affinity - But this opinion is rejected
tho' term is still employed to denote that pecula
Species of Attraction strictly denominated Chemical

2 This takes place only between the minute particles of bodies

3 Chem Attraction takes place only between particles in contact

4 This requisite for the Efficiency of chemical attraction that one of the ingredients be fluid to this there are a few exceptions — advantages of fluidity are that the particles are brought in to greater proximity — they can more readily obey the changes requisite to chemical combination in a fluid medium admits a ready motion of the particles — the cohesive attraction between the different bodies particles is diminished — Mechanical means have been often employed to promote this end mechanical effect as grinding pounding &c since it has been said that as you diminish cohesive attraction you increase Chemical Attraction but a more direct mode of proposing the fact is that the Efficiency of chemical attraction increases as you diminish (the cohesive attraction

Chemical attraction takes place only at certain temp or at certain temp in presence of others — an elevated temp is generally most favorable to this effect, this has been attributed by some to the

power of Caloric in Diminishing cohesive Attraction, others suppose it to be ~~[illegible]~~ by virtue of its own Attraction

Cold seems to oppose chemical attraction – if water in w.ch salts are dissolved be exposed to equal degree of cold – Ice will be produced and fluid and the Salt ~~precipitated~~ separated but the Cause of this in reality is that the cohesive Attraction is so great as to overcome the chemical attract.n

When Chem Attraction takes effect a Combination invariably takes place accomp.d usually with change of Temp. and the Comp.d ~~[illegible]~~ acquires qualities and properties peculiar to itself

7 Attraction of Composition may be exerted ~~by~~ between more than two Substances sometimes between 4 or even 5 – but in these cases the attraction is exerted not simultaneously – but successively

8 When a Chemical Attraction subsists between one body and several others – the force of the attraction between it and different Bodies is different in almost every Instance – On this law depend

all these chemical decompositions arising from the addition of a third substance wh. third substance in order to this effect must have a greater affinity for one of the ingredients of the Compd. than this Ingred has for the other ingred. of sd Compound

(It shd be observed that when we say one substance is said to have an attraction for another it is always to be understood that this attraction is mutual ~~mut~~ or reciprocal and speaking accurately it may be said that it exists between ye substances) — the Fact to wh. this law refers has been denominated elective attraction — and the instance before mentioned where a simple third body was employed viz potash to detach the lime — is called a single elective attraction —

It is of great consequence to ascertain the order in wh one body attracts several others — This can only be done by ~~way~~ observation and experiment — a great vary of observations & experiments of this sort have of late years been made & the knowledge thus acquired is now thrown into Tables

—Tables of single elective attraction illustrated —

It has been imagined that a repulsive force existed between the body separated but the fact is that there is simply no attraction — sometimes however

an Attract. Force subsist between the Bodies and
Attract. Compound is formed
The Order of Chemical Attraction is invariable under
the same Circumstances — but there are certain
Circumstances which give birth to apparent irregular
ities — two of the principal are 1 Decomposition
Difference of Temperature. Either alters the order of attrac
tion — If the bodies disagree in volatility & fixity the
means of Temp. will weaken their Attraction for
each other,
Thus as low Temp. the attraction between Potash and
Sulphuric Acid is greater than between any Base and
any other acid, but if the temp be raised the Phos
phoric acid will disturb the Sulphuric being less vo
latile. Hence Tables have been formed of elec
tive attractions in consequence of Heat
M. Berthollet has endeavored to lay down some new
views on this Subject — That the whole amount
of attraction between two bodies depended not
only on the relative force of attraction between
them but also on the Quantity of the substances em
ployed — so that tho A may have a greater attract.
for B. than it has for C. yet C may be added
in a Quantity so much larger than the Quantity
of B. as to overcome the attraction between A & B

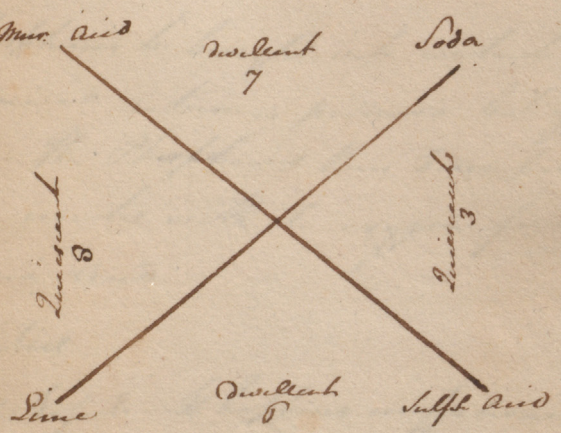
Hence he asserts that no body is entirely detached in their operations which incompleteness of Separation depends on the compound of the same kind Chemical attraction and of the Quantity of the respective bodies — These principles seem to me deserved that I think we ought to admit them. — It is a fact well known that in order to separate a compound part of a compound a much greater Quantity of the third dissimilar substance must be added than would have been sufficient provided to have saturated the other the part of the Compound provided it had been uncompounded — and during the Combination it has been observed that the force of attraction diminishes as the point of saturation approaches

It still remains true that under similar circumstances the order of Attraction is steadily and invariably the same — but it would be a great help if we could discover the numerical difference between Attraction with any body has for another one substance and for every different Substance in the series

— The laws of elective attractions explains certain Phenomena formerly mentioned that when two substances act chemically on each other they cannot interchange each an ingredient this is sometimes termed double elective attraction ——

Thus if we mix Muriate of Lime and Sulphate of Soda — the Lime unites with the Sulphuric acid & falls to the Bottom & the Soda combines with the muriatic acid —

The affinity in this Case between the Muriat of Lime — & also the affinity between the Sulphuric acid and Soda are called quiescent affinities The affinity between the Lime and the Sulphuric acid between of Soda & muriatic acid are called (Double ~~affinities~~ affinities — and the Sum of the two Double affinities being greater than the Sum of the two quiescent affinities — this decomposition takes place



If the force attracting of muriatic acid to the Lime be as 8. — and that between Sulph. acid & Soda as 3 — and if the double attract. between Soda & Mur. acid be as 7 and that between Lime & Sulphuric acid as 6. ——

It will be evident that the sum of the double attraction 13 will overcome the sum of the quiescent attraction 11

It happens in certain cases [illegible] that when two bodies are brought into contact alone they will not unite, but readily combine on the addition of a third body which third body has no attraction for either of these two bodies when uncombined but has acquired attraction for the compound which is formed by their combination

This is called disposing attraction — Lead and oxygen alone will not combine — but if Lime or Potash be added (both of which have a great attraction for the compound resulting from an union of Lead & oxygen — namely Nitric Acid) such an addition will greatly favor this combination

So if Phosphorus be brought into contact with water no chemical action is produced but if lime be added — the Phosphorus then decomposing the water unites with its oxygen forming Phosphoric Acid

Apparatus —

Chemical Vessels It happens unfortunately that neither Nature nor Art can furnish us with any substance possessing the various Qualities required in Chemical Operations — These Substances and Qualities are — That they it shd not be operated upon by any corrosive menstruum — that it shd be of strength to resist any [illegible]

expansion or per — That it sustain without injury any elevation & every change of Temperature and that it shd be transparent

The Substances employed are Glass Metal Earth Glass resists corrosion is transparent & imperviable to fluids tolerably well but will not bear a sudden change of Temp: — For the effect of heat is to expand every substance & glass conducts (slowly) very slowly so that no part of the glass endeavours to expand before the heat has penetrated into its substance and consequently before & other part of the surface of the glass is expanded — in consequence of which a crack is produced

Hence it arises that thin glass is much less liable to crack from unequal Temperature than thick glass or is that thin heat is readily transmitted thro its substance Green Glass sustains a higher Temp than Green Glass and the best Flint Glass then Crown Glass — The glass shd be well annealed that is very moderately cooled — experiment with ill annealed glass shewing how readily it is broken especially by any sharp hard angular substance as a bit of flint

The extreme fragility of glass Crackers is — are made by dropping melted glass into water may illustrate the reason why glass breaks so readily when ill annealed — If the external surface

be cooled upon a Internal — the external surface will contract in proportion to its distance of Heat but the internal surface being at this time of a much higher temperature will be prevented from contracting farther in proportion as it cools by its adhesion to the external surface wh has already arrived at its maximum of contraction hence if its contracting power does not break the glass it must remain in a State of extreme rigidity & the slightest vibration or change of Heat may be sufficient to break it

Experiments with unannealed Glass and with Glass Crackers

Crackers have the disadvantage of being annealed by certain substances & they are also untransparent Gold Silver and Platina might be usefully employed on account of their hardness & the small heat required to fuse them but are too costly for general use

Earthen vessels especially of Porcelain ware have alternations of Temp without injury but an untransparent Porcelain peculiarly adapted for Chemical purposes

Forms of Chemical Vessels — Solution Glass — Matrass — Florentine Flask Papin's Digester

the vessels used in fusion of the substances are corrosive are made of glass — but if a higher Temperature is required than the glass will sustain Crucibles formed of a mixture of sand and Clay are employed — a small Crucible containing the subject of the experiment is placed in a crucible of a larger size and a stratum of sand interposed — a mass of Clay & sand is also placed occasionally between the bottom of the Crucible and the fire — Crucibles made of Clay and Plumbago bear a high Temperature and variat of Temp better than those of sand & Clay but in very intense heat the Plumbago is consumed The best of all Crucibles are those of Platinum — Evaporation — this may be carried on in Vessels of Copper or Silver or in Wedgewood evaporating Vessels — where it is an object of consequence that the heat may not exceed 212 as in the evaporatn of water from Extracts &c. then evaporating bowls may be exposed to Steam

Distillation per descensum by placing the fire on a plate of Iron over the Substance as in distilling oil of cloves per ascensum common Stills & refrigeratory — Spiral worm is unnecessary & obtained with greater difficulty than one less curved — If the subject

of ye process be common Glass Cucurbits with Capitals & receivers fuming &c. is called an Alembic are made use of

If the vapors to be drawn over are ponderous a retort is used — with a condenser fitted on its neck Retort funnel occasionally necessary to prevent Contamination of ye neck of ye retort

Tubulated retorts when ye operation begins the moment ye Substances are mixed, Tubulated Condenser to prevent ye expansion of vapor from bursting ye apparatus — Condenser kept cool by wrapping linen round it on which water is caused to drop in ye mode of Filtration by woollen threads — or worsted

Range of adopters contrived by Woulfe to condense volatile vapors —

To condense or collect vapors not condensible by common means Woulfe's bottles — with connecting tubes & a tube of safety which must be higher than ye sum of ye Columns of water whose resistance the vapor has to overcome in passing thro the whole range

When great heat is requisite retorts of earthen ware or Porcelain — of Green Glass with a Coating lute

Separatory

Sublimation – cucurbit & capital – blind Capital
common bottles – Ranges of Capitals have formerly been employed to collect ye products of great
& less volatility called
now disused

Pneumatic Apparatus
a Solution Glass with
curved neck
flexible necks of brass wire
in a coil with coverings of oild silk – caoutchouc
band. Pneumatic Shelf Gazometer &c

1 Having finished what I purposed to say on the Vessels necessary for ye reception of the Subjects of the Experimt. I proceed to consider

2 the method of producing a change of Temperature

Increase of temp is occasioned by

1 the Rays of ye Sun – 2 Animal heat – 3 Mechanical Heat – 4 Electricity – 5 Chemical Combination 6 Fermentation 7 Combustion wh might indeed be included under Chem Combination

1 Sun's Rays – When ~~[illegible]~~ conducting substances were removed as completely as could be done Ct Rumford found the heat caused by the Sun's Rays equal to 176° – This Solar Heat is employed for drying certain substances – & for Hatching Eggs but is too unsteady for Chemist who employs the Solar rays collected into a Focus by a Speculum or Lens

The largest Speculum ever employed was that of Celebrity of Lyons of 43 In: diam & 4 feet of half an Inch at ye distance of 3 feet — which instantly melted Iron Silver & Gold Chemhausen constructed a Lens of 4 feet diameter at ye Dist. of 12 feet of an Inch & ½ — This is not so powerful as a Speculum of the same size but in its focus even the Diamond has been brought into a State of Combustion — One great advantage of Lenses & Specula is that by them Heat may be transferred to a body enclosed under a glass Apparatus — but when a quantity of glass is required for the formation of large lenses is employed it is thereby liable to contain Specimens in some part of its substance, hence it has been proposed to apply ye edges of two convex portions of a Sphere (as eg. watch glasses) together & to interpose water or alcohol between — but an inconvenience attending this structure is that ye fluid expands & contracts in proportion to ye increase or diminution of Heat to which it is subjected —

The Count de Buffon formed & described an instrument consisting of a number of small burning glasses so

1/ I. b.d 104°

instructed that they could be made to reflect all their rays on one object — and by this he set fire to a Piece of wood at a distance of 50 Paces — in a small way we have good reason to believe Archimedes of Syracuse set fire to the Ships of the Romans

Animal Heat is rarely made use of by Chemists it may serve to graduate a Thermometer — being usually at 98° or from 96 to 100 ℔

Mechanical Heat is that excited by Friction by Percussion & Collision — I spoke of the cause of this is explained in a former Lecture it is used by the Chemists

Electricity — Whether this be allied to Heat or not is not yet determined — The electric fluid passing thro Gold or Silver has been known to melt them — Money in a Pocket has been melted when the Pocket itself was uninjured — A Point of a sword has been melted when the Scabbard has not been at all affected — The reason of which is That the electric fluid when thus accumulated in a point is much more powerful than when flying from this point / it is widely diffused The electric fluid is employed by the Chemists to

fire Gases contained in close Vessels as more especially in ye formation of Water from the Hydrogenous & Oxygenous Gas — and in the decomposition of Water and Ammonia

Galvanism seems in some Circumstances a more powerful Agent than Electricity in its usual form but of this I shall speak hereafter

Chemical Combination — The Heat from this Source is rarely employed by the Chemist except in a domestic way as e.g. to light his Candles

— Exp. Hyperoxyg. Mur. of Potash with Sugar — Particle of sulphuric Acid brot in Contact — the result is a bright flame

Fermentation This is divided into vinous acetous & putrid, during the two last a great degree of Heat is generated — This it is that renders Horse dung so useful in forming hot beds manure &c and the Heat during its putrefaction which goes on very rapidly is about 120 a 140°. — Tan bark putrefies more slowly — & the Heat produced is not so great but is proportionably more permanent — This Source of Heat is employed in ye making of Vinegar and of White Lead by ye fumes of the Vinegar It is on this principle that Hay Stacks when put up moist ~~take fire~~ putrefy and smoke & even take fire

Combustion, this is in reality a chemical Combination between the Oxygen of the Air and the inflammable body — The substances used to procure heat by their Combustion are 1 Fluids 2° Turf or Peat 3 wood & Coal 4 Charcoal & charred Plants

— The fluid Substances used to burn in a Wick are Alkohol and oils — Alkohol is especially proper to be as its heat may be perfectly regulated by the number & size of the Wicks and as it burns without any soot to sully the Vessels that are contiguous — one of the Alkohol & pure does not leave any residuum — Oil is analogous in its combustible properties but inferior to Alkohol emitting an offensive smell and intolerable smoke

Every inflammable body during combustion emits a Quantity of Vapour and this uniting in contact with the Oxygen of the Atmosphere burns luminous forming what we call flame but the Alkohol & Vapour is not exposed to the action of the Air being included & included in Vessels of external inflamed surface This confined Vapour undergoes a certain Change and is deposited in the form of soot — The expedient to prevent this, which is in some degree effected by making the Wicks very small or very flat which answers the same purpose viz. exposing

exposing as much as possible of the vapor emitted to the action of ye oxygen principle in ye air This is done still more completely by the patent Lamps which was lately invented by Mr Bolton & in wch ye air is made to pass thro ye flame arising from a circular wick — Still however a quantity of charry substance is deposited on the wick wch soon obstructs its action for the wick is merely a mechanical contrivance to suck up ye fluid by ~~capillary~~ capillary attraction and thus expose it to combustion — To remedy this Inconvenience it has been proposed to employ the earthy substance called asbestos but this is found to be subject to the same objections.

Another contrivance in wch a stream of air is made to pass thro the Center of a flame is that of the blow pipe — — Blowpipes for ye mouth with bulbs near their extremity to condense ye humidity of the breath. Dr Black's blowpipe

A Candle for this operation shd be formed of wax or of Tallow with a paper round it — the spoon for containing ye subject of the experiment of Platinum — Certain substances are occasionally added to assist the fusion these are called fluxes, such are the

Borate of Soda — Soda itself — Phosphate of Soda and Ammonia or microcosmic salt

To supply the place of the lungs a bladder may be used or the double bellows of Nooth — or a Gazometer — the highest temp that can be obtained is when a stream of oxygen gas is made to pass thro a flame in this way — the subject of the experiment being placed on the incandescent charcoal — Exp — the fusion of ~~Charcoal~~ Iron — to increase this to the utmost the Gas sh^{d}. be heated by passing thro a lamp before it arrives at the Charcoal

Count Rumford considers this effect as purely mechanical — doubtless it is partly so and partly in consequence of the complete combustion of the vapor —

2 Peat or Turf is copiously produced in some Countries consisting of Vegetable matter in a peculiar state of decay, this burns rapidly requiring freq^{t} renewal

3 Wood & Pitcoal — Pit Coal gives a higher temp than any substance we can employ — but is unfit for moderate temp — as if kept bright by the free admission of air it is in small quantities it requires frequent renewal if not kept bright it yields a great portion of smoke

4 Charcoal & Charred Pitcoal — Charcoal burns evenly kindles readily — emits no smoke deposits few ashes but wants very frequent renewal — Charred

Wood from which the volatile matters have been expelled is easily kindled ~~burns rapidly~~ gives a strong heat — emits few vapours & is durable it might form a valuable article of domestic economy especially if the heat in its Charring & the Pitch of the coal were applied to useful purposes so that the Charred Residue might be procured at a cheap rate — Wood in charring loses 2/3 of its weight & gains 1/3 of bulk — This is of most convenient & useful for chemical purposes

2d The Mode of decreasing Temperature

This is done by Chemical Mixtures & by Evaporation You have already seen the effects of Evaporation & are acquainted with the reason why it produces a Diminution of Temperature because when a substance is converted into Vapour it absorbs a large portion of Caloric which passes into a latent State and that this effect is varied according to the Volatility of the substance — and the dryness & humidity of the atmosphere the degree of increase of cold produced by the Evaporation of water is from 5 to 12 degrees of Alkohol about 20. & of Ether 60 — and by the Evaporation of Ether Ice may be produced at any season of the Year

Mixtures of Snow or pounded Ice with Neutral Substances

cause it to melt with great rapidity — There are compounded and an alkaline Compound — Muriate of Lime made in the winter with great care about 3 parts by weight & snow kept as dry as possible by being covered with snow on all sides about 2 parts were mixed in a vessel previously cooled and by this mixture Quicksilver may be frozen —

Exp: — the freezing of Quicksilver by this process

This mixture if properly conducted lowers the Temp: about 80 degrees

1 Another Compound Salt is Muriate of Soda or common Salt, 1 part to dry snow 2 parts produces a degree of cold equal to minus 5. and this is daily employed in making Ice Cream

If other Salts be added to the ~~Compound~~ mixture a still greater degree of cold will be produced — thus if * snow Muriate of Ammonia be added — the Temp sinks to m. 12° — If to this you add Nitrate of Potash it sinks to m 18°.

The mixture recommended by Mr. Walker is Snow 12 muriate of Soda 5. Muriate & Nitrate of Ammonia aa 2½ parts, a good Mixture is Nitrate of Ammonia Muriate of Soda aa 5 of Snow 12. Cold thus produced m 25

But a mixture of Snow or pounded Ice or hoar frost 2 parts — Muriate of Lime 3 parts is much

principle and this has produced a cold of 4° 68
— The Muriates of Magnesia and of Iron have
a powerful effect when mixed with snow but
not equal to that of the Muriat of Lime
Acids a Mixture of them with snow produced a
Cold of 4° caused Fahrenheit the constant to his
descending Series —

If 4 parts of fuming Nitrous Acid and 7 of
Snow be mixed a degree of cold is produced equal to 32°
or the total of the cold produced will be about 60 and
calculating the snow to be at 30 below 0 of Fahrenheit
— If both the Snow and Acid are previously cooled
by a mixture used subjecting them to the action of
a frigorific mixture of a similar kind the degree
of cold produced is equal to 45 If the
Muriatic Acid be used instead of Nitrous a degree
of cold not quite so intense will be produced —
as it produces a Temperature of Frost about
53 degrees only Fahrenheit
Sulphuric Acid may be employed to generate Cold
with snow — it should be first diluted with about half
its weight of water or steam is created on the
mixture — this should be suffered to subside before
making the experiment — If Sulphuric Acid and
snow be mixed at 32° the cold produced is about 3°

But as there is a maximum of Cold wch these mixtures are capable of producing beyond which maximum the acid or saline body ceases to act on ye snow (as that for instance mixtures of com Salt & snow can never produce de ~~[illegible]~~ cold more intense than m 3 or Nitrous Acid & snow cannot produce a cold greater than at m 46. by any succession of mixtures) Yet it is the peculiar excellency of sulphuric Acid that its maximum of cold when mixed with snow is farther from Zero than the maximum of any substance wch has yet been tried — so that if the substances employed — the Sulphuric Acid & the snow be cold by previous successive refrigerations till each is at m 70 and they be then mixed a degree of cold may be and actually has been produced equal to m 90

If Alkalies are employed a consid: degree of cold may be induced — If Caustic Alkali and snow be mixed at 32 the mixture indicates m 53 — or a cold is produced equal to about 80 degrees But this is more costly & troublesome than the muriate of lime — wch last substance is very readily recovered by evaporating ye mixture & is then equally fit for a repetition of the experiment

In course of this production of cold has been before explained viz: the absorption of a large quantity of Caloric wh. passes into a latent state during the liquefaction of the Salt or snow

But snow in lieu cannot always be procured and in that case — the same principles — salts may be employed wh. are at all times accessible and are dissolved in water or acids

— The cold produced by solution of Muriate of Soda in water is not very great, if 5 ounces of that be dissolved in water it produces 19 degrees of cold — a mixture of Ammonia 32 degrees Nitrate of Ammonia diminishes the Temp. of an equal weight of water by no less than 40 degrees — that is they wd reduce the Temp from 50°. to 4°

When a mixture of one Salt with water has lowered the Temp by addition of another salt will increase the reduction — Thus if with water at 50 you mix an equal quantity of Nitrate of Ammonia the Temp will be reduced to 4 if to this you add the Carbonate of Soda it will be reduced to 0

If you take of a mixture of Nitrate of Potash and muriate of Ammonia aa P. 3 Parts and of water 4 Parts will reduce the Temp from 50° to 4°

Here Salts may be recovered by evaporation and

This is one of the cheapest and most convenient
modes of forming Ice & producing cold in the
middle of Summer in a large way
If the Salts are dissolved in Acids effect is increased
thus if the Sulphate of Soda 5 Parts be mixed with
Sulphuric acid previously diluted with an equal
wt. of water 4 Parts be mixed at 50° the mixture
indicates 3 — Thus may be measured by
Dilutions

Muriatic acid 5 Parts sulphate of soda 8 —
with addition of Temp from 50 to Zero
Red fuming Nitrous acid diluted with ½ its wt
of water 4 Phosphate of Soda 9 — mixed at
50°. with ice to 12°
The effect is increased by adding dissolved Salt &
ice together — Thus the diluted Nitrous acid
above directed 4 Parts add Sulphate of Soda 6
& Phos Nitrate of ammon 5 Mixture will
sink from 50° to 14° — or 36 degrees
or Diluted Nitrous acid 4 Phosphat of Soda
3. Nitrate of ammon 6. from 50 to 21
or 29 degrees of cold will be generated
— If the Salts to be employed are cooled in ice
before a degree of cold many Times greater produced
sufficient to congeal mercury in a middle of

increase without one Particle of Ice or snow as was ascertained by ye experimts of Mr Walker — But here there is a maximum of cold when ye bodies cease to act on each other

— The Salts employed shd be such as have been recently crystallized pure fairly powdered and containing all their water of Crystallization for if this be expelled instead of cold they generate heat — manifesting the analogy of ye Cause producing ye cold here with that wch operates when snow or ice are employed for in both water is in a concrete state & paſses during the experiment into a state of liquefaction

Chemical Apparatus for applying increased Temp:

Furnaces — a stream of Air is maintained thro ye body of ye furnace by ye ascent of the heated Air in consequence of its diminished specific gravity and the Air of greater specific gravity preſsing into ye space it occupied —

— On ye same principle Smoke ascends in our Chimneys — a circumstance of importance to Domestic comfort and wch has engaged the attention of two of ye greatest Philosophers of ye age — Dr Franklin & Ct Rumford — the latter has suggested the means of remedying the prevailing

a chimney from smoking viz by securing a sufficient draught of fresh air to counterbalance the heat of rarefied air which in some of our air-tight rooms must be done by apertures and it has been proposed to make them under the grate in to convey the air by a tube of brass to the back of the grate — By contracting the fireplace and its back that the vapours in favour of the Chimney may not be too widely diffused — and in lay removing the mechanical obstruction to the ascent of the vapour as soak bricks &c and in case an body of cold falls in the top of the Chimney from a neighbouring House or hill lay erecting the top & making a lateral opening Furnaces have been employed to ventilate mines and have been proposed for ventilating the wards of Hospitals — Thus at Newcastle a stream of pure atmospheric air passing in at the ground opening into the mine is made to describe a tortuous course carrying with it the foul air which passes in a different course thro which it passes first at length it passes out of the mine Thus a furnace properly contrived and fixed at the foot of a counter opening made for this purpose

at the distance perhaps of fifty Yards from
from a grand opening is dispersed into the
air

Description of Furnaces — and of Lutes
for Calcination Matters are employed —
Vases of Porcelain Agate Granite Porphyry
Iron or which is generally best of W. Wedgewood
manufacture

Balances in company for general purposes
that they should be so nice as those of
C. Fordyce or Ct Rumford

For measuring Liquids graduated measures
of Glass are employed. and there may be
several scales according to the different
density of the substances employed as
one for Alcohol another for water a
third for Sulphuric Acid &c

In determining the specific gravity or density
of bodies ~~water~~ the specific gravity of distilled water
is generally taken as a standard and con-
sidered as unity — The body whose specific
gravity is to be determined is first weighed in
air — It may then be suspended by a human
hair to the bottom of the scale and weighed in
water and its loss of weight in water is equal

to the weight of a bulk of water equal to the bulk of the solid thus weighed — wt. water it displaces — Divide the Weight of ye Solid in air by its Difference of weight in water & ye quotient will indicate its Specifik gravity Thus e. g. If a stone is found to weigh 600 grains in air & 500 in water — by wt. I find that a bulk of water equal to the bulk of the stone is 100 grains I divide its wt in air 600. by its diff. of wt in water 100 & it gives me 6. which telling the water as unity is ye Specifik gravity of ye Stone — or in Other words I find that one cubic inch of ye Stone weigh as much as six cubic inches of the water

It is often of great importance to ascertain the Specifik gravity as it may afford a Characteristic of ye substance or may point out ye Strength of Alkohol (e. g.) by its Increase or of Sulphuric Acid by its Increase,

The Hydrometer of Nicholson (exhibited) now called the Gravimeter — The Temp. of water agreed on for weighing Specifik gravity is 60° and Distilled water employed for ye purpose

Weighing bottle exhibited of a cylindrical form with a perforated stopple that it may be always equally

filled — Clarke's Hydrometer — W. Lawrie's —
Hydrometer for common substances, Spirit Bubble.

To measure the Quantities of gaseous substances
by glass graduated to cubic inches &c. to be employed
and the operation carried on under water.

To ascertain the specific gravity of gases a glass
Balloon may be employed connected with an air
pump by which all the included air being exhaus-
ted the Balloon is weighed and filled with the Gas then a stop-
cock and weighed again the atmospheric air is
here always considered as unity — and the capacity
of the Balloon being known the specific gravity of the
included gas is easily found — or this may
be done by an Hydrometer or bell of which
is filled with the gas whose sp: grav: is to be
determined

Part II

Of the more particular Doctrines of Chemistry — We are now to enter on a Detail of the properties of the most known substances natural and artificial — The effects of heat upon them and their relations to other substances —

There are two modes of pursuing Philosophical inquiries 1st Synthetical and 2d analytical In the first we proceed from what is simple to that which is more complex — In Analysis we take what is complicated & pursue it into its minutest Ramifications — Chemists in pursuing the Synthetical mode of investigation — describe first what are called Elements or those bodies of which cannot be resolved into any other and of which all other are composed — That there are such Elementary bodies we cannot doubt but the number and the kinds of them enumerated by Chemists in different ages have varied extremely — In a long time the Aristotelian Philosophy prevailed and 4 Elements were considered to be Air Water Earth and Fire — Paracelsus doubting of the Propriety of this Doctrine asserted that the Elements were Sulphur Salt and Mercury

This doctrine however soon passed into merited oblivion – and Chemists continued to adopt the Aristotelian Doctrine till the middle of the last Century and Macquer who published the best book that was extant in Chemistry 15 years ago – treated of Air first then Water 3rd Earth & 4thly Fire – he next proceeded to the Salts &c But late experiments have proved the Air to be a Compound of at least two if not of three Ingredients – And Water ~~has~~ was found by the experiments of Mr Cavendish to consist of Oxygen & Hydrogen – Of Earths there are seven different kinds and respecting fire it is scarcely determined whether it be a body or not or whether it be a simple or compound. this my own Opinion is that Fire is an Element

It is a prevalent Opinion among Philosophers that the ultimate Atoms of all bodies are the same – whether these be solid or merely attracting and repelling Points no body pretends to know any thing about them or the mode of their arrangement

The term chemical Element is still employed to denote those bodies which cannot be formed by a mixture of any other bodies – which

cannot be resolved into any other bodies
and by a Combination of which all Mists are
supposed to be formed
There are nearly 40 in number
2 Alkalies — but a decomposition of the volatile Alkali
has led to suspect that the Others may
be compound bodies
3 Acids — Muriatic Boracic & Muriatic (which
two last are now said to be compounded
Ten Earths — but Davy has asserted that he has
decomposed two of these
2 Gases — Azotic and Oxygenous
4 Inflammables Sulphur Phosphorus Hydrogen & Carbon
19. 20. or 21 Metallic Bodies
Some Chemists have chose to consider them
as no compound bodies being combined with
the matter of Heat or Caloric
Diversity of union forms a diversity of bodies
hence binary Combinations Ternary Combinations
Chemical Elements are used daily decomposing
and this to such a degree it might seem adviseable
to begin with simples and proceed to com-
pounds — Yet from this Circumstance our Knowledge
of it is unstable and Unsettled in practice It is
found very difficult so the last work of Chemistry

Besides we shall be led to treat of substances agreeing in simplicity but being compounded of two or three ingredients but agreeing in nothing else so that on the whole I think it best to adopt the plan of considering them according to a similarity of quality and character and here we must often follow the analytical plan

The most obvious distinction which always presented by Natural history is into animate and inanimate world - dividing the first into two Heads — viz animal the vegetable & Mineral Kingdom — This division I adopt & retain intent tho not entirely

I first premise an account of the constituents of the air of the Atmosphere — then Saline Substances — Earthy substances — Inflammable substances — Metallic Substances — Mineral waters — vegetable bodies

— The Composition of the air of the Atmosphere is an important illustrious discovery of our Province

The air is a transparent light elastic mobile and invisible fluid — surrounding the terraqueous globe to the distance of about 45 Miles and pressing by about 15 lbs on every sq: Inch

The Specific Gravity of the Air is as 1 to 815
of Thermometer being 55 & of Barometer at
30 Inches — for in experiments of this sort the
Thermometer propose to be taken into
the account — One cubic inch of Air at
54° is said to weigh ~~31 Grains~~ 31 Grain
Of the Qualities of Atmospheric Fluid I
can say but little — Nothing first the
effects of Caloric upon it 2° its relation to
some substances already mentioned
The amount of expansion of Air by increase
of temperature on degrees as variously stated
by De Luc & Roy Reaumur Sir G. Shuttleworth
Du Veonois & Dr Priestley De Luc says that
it expands when raised from 70° to 71° by 1/480 of its
bulk — Sir G. Shuttleworth 1/412 Count de Roy
1/409 Sanctorio 1/530 Dr Priestley only 1/605 —
Dalton & Dulong have found that the ra-
tio of expansion increases according to
the increase of temperature and that in rising from
32 to 212 its bulk was nearly doubled
— No chemical Changes produced in the Air
by Caloric —
Air is contained in water from which it may
be expanded by Boiling freezing exhaustion

chemical Attraction — and I have before remarked that the Air dissolved a consid: portion of water Saussure computes that a Cubic Foot of Air holds in Solution 7 Grains of water — and this solvent power is doubled by every increase of 17 degrees of Temperature according to Leslie

Air has a consid: solvent Power with regard to many other substances

The presence and renewal of the Air is requisite to respiration and combustion

— Air is a compound body and one of its component parts ministers to combustion & to life this was discovered by Priestley Scheele & Lavoisier about ye same time in ye year 1774. The Priority seems due to Dr Priestley who discovered it on the first of Augt in that Year it is called Oxygen Gas or vital Air pure Air Empyreal Air Dephlogisticated Air &c — It is transparent invisible inodorous & insipid — a cubic Inch of it weighs ,34 of a grain — If its temp. be raised from 32 to 212 its volume is increased by 5½ times according to Morveau & Duvernois — ~~the~~ the expansion is not so great at first as in atmosp Air but greater as ye Temp increases ——

Exp with a recently extinguishing Candle — with Sulphur

Beautiful Experiment of the conflagration of Phosphorus in Oxygen Gas — the Class room being darkened
Oxygen Gas will support the Life of an animal immersed in it six times longer than an equal bulk of atmosph. Air — and on dissecting the animal a slight degree of Inflammation is found in the Lungs —
If another animal is then inserted into the same portion of Air it does not prove fatal so soon as we might be led to expect a priori
The Capacity of Oxygen Gas for Caloric is said to be as to that of atm: Air as 4789 to 1000
~~[illegible]~~
Lavoisier computes that its proportion in the Atmosphc: fluid is ,27 — this is determined by exposing Atmospherical Air to substances absorbing the Oxygenous part and examining the Quantity remaining. Berthollet asserts that by experimts at Grand Cairo & at Paris he found its proportion only ,22 and this uniformly at every successive trial the Exper. of Mr. Davy as well as some I have made myself seem to favor Berthollet's Opinion

Humbolt whose experimts cannot be relied on with so much Confidence as those of some other Chemists maintains in the propor

of Oxygen in the Atmosphere is not so steady as was generally supposed that after much rain it was about .28 or .25 but when the sky was blue in general from 27 to 28 or 29 at the Pike of Tenerriffe it was only .19

There are many Causes constantly tending to diminish the quantity of Oxygen in the Air the Causes of its renewal may be mentioned hereafter

It possesses great activity and has a great Attraction for combustible bodies — for metals &c and from the stone it has in the formation of acids it is termed Oxygen

The word Oxygen Gas as a Combination of a Base & Calorick we cannot decompose it but it becomes evident when it enters in to Combination with other bodies and termed Oxygen It has been supposed that this Gas contains a large portion of water but this is not supported by positive proofs

We cannot like at present how to separate it in its pure garous form from the Air of the Atmosphere — but it is formed by an elective attraction and by light from certain Chemical Substances from Vegetables &c which we shall treat hereafter

It has been proposed in some cases in those complaints which were supposed to arise from a defect of that principle in the blood which oxygen communicates as Sea Sickness - but its use is now laid aside in this respect

It has been proposed to throw oxygen into the lungs in cases of Suffocation or drowning

It is employed to produce the highest degree of Inspiration as you have seen

Azotic Gas is the other Constituent of the Atmosphere also form air Phlogisticated air Mephitis Nitrogene Septon &c many have considered many of the diseases of this Gas but this term is really due to Dr Priestley Dr Rutherford and especially Scheele

It is transparent colorless insipid & tasteless its specific gravity compared to Atmospheric air is as 985 to 1000 One Cubic Inch at the temp of 55° & barometer being 30 weighs .305 of a grain or about 1/3 — It is expanded in passing from 32° to 212 to 5 times its former bulk but this ratio of its expansion is not equal for it is greatly greater in the first 2 of the heat — It is unfit for respiration or Combustion experiment with the lighted taper but that it is a direct Enemy to either respiration or combustion but proves so merely by excluding

oxygen gas — The proportion of azotic Gas in
the atmosphere according to Lavoisier is .72 -
according to Berthollet .78
Uses of Nest are not fully known, it serves to
dilute the oxygen gas of the Atmosphere but pro-
bably serves other useful purposes in the Economy
of Nature with which we are unacquainted
It perhaps only serves with part of the capacity
of oxygen for Calorie viz .793
Its combinations are to be spoken of hereafter
It is supposed like oxygen Gas as an element
has existed to calorie and we have not been
able to exhibit it in its purest state uncombined
It may be obtained by the putrefactive Animal
putrefactions and from the air of the Atmosphere
- It has been employed by Physicians in certain
cases but is now laid aside
Carbonic Acid Gas has been generally enumerated
among the Constituents of the Atmosphere and in-
deed it is constantly found in it in the proportion
of about .01. I consider it not as an essential
but merely an accidental Ingredient
It is not yet decided whether the Ingredients
for constituting Atm. Air be mixed in the Atm.
Chemically or merely mechanically

For a chemical union it is urged that the Capacity of Atmospheric Air is not ye mean between ye Capacity of Oxygen Gas & Azotic Gas — and so also of their expansion by heat when separate and then mixed and that as they differ in Specific Gravity they wd separate from each other were they merely mechanically mixed — On ye other hand it is urged that agitation prevents them from separating from each other and that after suffering atmospherical Air to remain at rest in a tube for 12 months that ye azotic gas was found at ye top ye oxygen gas at the bottom of ye tube — It is urged further that each constituent part retains its distinct properties and enters as such into Combinations with other substances

I need scarcely mention an opinion that the life of ye Antediluvians depended on ye larger portion of oxygen in ye Air as such a larger proportion wd render it ye more unfit for respiration

I now proceed to inflammable substances —
I shd proceed immedy to saline bodies but that you may understand ye component parts of some of them more fully I shall premise a very brief account of the Chemical Inflamm:

Hydrogen Sulphur Phosphorus & Carbon

Hydrogen combined with Caloric forms Hydrogenous Gas — this is an elastic incompressible not quite inodorous body — and the most attenuated of all unfixable bodies — for lightest if we admit it to be a body is most attenuated

It is certainly only 1/10 or 1/12 of the weight of Atmosph Air

Exper Combustion & Explosion of Hydrogen Gas with oxygen Gas & with atmospherical Air —

Oxygen & Hydrogen in the proportion of 15 of the latter to 85 of the former — when properly combined form water of which I shall have to speak at large and to exhibit in a future part of the Course

Hydrogen with azot form ammonia

Sulphur burns with a bluish flame — emitting suffocating vapours — wh by combination with the oxygen of the Atmosphere forms Sulphuric acid — it has no disposition to unite with the Air — is not soluble in water

Phosphorus — resembles white wax in appearance when heated it becomes soft — [illegible] when exposed to the Air its qualities become changed — it may be fused and volatilised if access of air is pre

prevented – it is luminous in the dark is kindled with a very slightly increased Temp. & shd. therefore never be handled without Pincers – burns very rapidly in oxygen Gas wth a most brilliant flame – It is not soluble in water – is slightly soluble in azotic Gas

Carbon – This can be exhibited in its solid form – it is not contained perfectly unmixed but nearly so in common Charcoal – a black brittle insipid inodorous infusible substance fixed in every heat that has been applied insoluble in water, burns without flame – but very rapidly in oxygen Gas as you have seen another Exp. demonstrating this

The Diamond is found to consist of pure carbon – Carbon has no relation to Acids

– Permit me here to state a few facts relating to Combustion – when an inflammable body becomes incandescent & undergoes the process of Combustion it was anciently thot. that either a part or the whole was consumed But in reality there is no destruction but merely a changed state of existence for if we collect ye product whether solid or gaseous it will be found heavier than

the combustible body was burnt — and this product is no longer susceptible of inflammation by treating it with certain chemical substances its combustibility may be restored

In order to Combustion and frequent renewal of the air is necessary and the air suffers a remarkable change during the process

It is found to be diminished in quantity and vitiated in Quality and this depends on the abstraction and change of its oxygenous Gas

Different opinions have been entertained respecting the nature of combustion and also of combustible bodies — It was supposed that all combustible bodies contained something which gave them their inflammable and which they parted with during inflammation this has been supposed to be oil — a Dr Stephen but Stahl maintained that it was a certain principle which he denominated Phlogiston and on this Principle he created a most beautiful System — Respecting Phlogiston he taught — That it was a real material substance — contained in different quantities in all bodies — that the separation of it may be accomplished by the access of air in vapour of water under ex

x and that this ebullition is attended with the
emission of appearance of flame

Circumstances* — That it is too subtle to be collected — and only cognizable by its effects — That it may be made to pass from one substance to another — but from its subtlety adds nothing to its weight or measure — That it possesses & superadds many other Qualities that to the Metals are their splendour malleability &c — Vegetables their color taste & smells

When it was discovered after the death of Stahl that the residuum remaining after Combustion was heavier than the substances before Combustion the disciples of Stahl contended that Phlogistic was not only not ponderable but that it was possessed of positive levity and that a body was disposed to recede from the Earth in proportion to the Phlogiston it contained

— It was strange that the effect of Combust^n upon the Air should have escaped the notice of so keen an observer as Stahl — Boyle Hook & Mayo had found the renewal of Air necessary to Combustion but still the system of Phlogiston maintained its ground till then in all the Schools of Europe till about 20 years 7 Nov^r //

when M. Lavoisier began to doubt the theory of Phlogiston and at length from a multitude of experiments had the confidence to deny its existence — The Constituents of the Atmosphere were clearly discovered and M. Lavoisier proved the nature of the oxygen & combustible body in each other — This is a point of consequence & therefore I shall exhibit it

Expt Combustion of Phosphorus in a receiver like Cylinder inverted in water — The air in the Cylinder diminishes in quantity and of course rises — M. Lavoisier made the experiment in order hermetically sealed setting fire to the Phosphorus by means of a burning glass — and weighed the substance with great accuracy before the Combustion and also after it without finding the smallest difference

The Phenomena of heat and light which take place during Combustion have not yet been satisfactorily explained — Stahl considered it as arising from a Principle of the Phlogiston which was supposed to be given out by the inflammable body — M. Lavoisier considering the Gaseous bodies

a compound of Celoric united to the base of the Gas - considers the heat & light as produced by the sudden separation of this Celoric from the oxygenous Base when it enters into combination with the inflammable body -

M. Crawford endeavours to explain this appearance by supposing that the Celoric is suddenly separated from the new compound in consequence of its having a smaller capacity for Celoric after the Combustion than both the substances separately considered before the union -

Author of these theory explain every case of Combust. the German Chemists especially - contend that the attraction of the new compound for Celoric is less than the attraction of the Constituents of the Compound before their union -

- Those who still endeavour to adhere to the Phlogistic theory suppose that the inflammable bodies are still of one nature base united to Phlogiston which Phlogiston is separated on the union of this Base with the oxygen -

The Language of the ancient Chemists may be translated into that of the moderns by substituting the presence of oxygen for what they considered

as the absence of Phlogiston and the absence of Oxygen for what they considered as the presence of Phlogiston

4 — Salts — in these bodies are next to be considered as they are of much importance agents in chemical Processes

These bodies are fusible or volatile in heat — soluble in water sapid uninflammable — a consonance of these Characters forms a body called in Chemical language a Salt — but all salts do not perfectly possess all these properties or some for instance are inflammable — Salts are usually solid, or usually fluid in this form — limpid or coloured — of greater or of less density

For our understanding of Salts to Calorie and to water — Salts when heated expand and come to ebullition — solid salts are melted some with a moderate Temperature as Nitre, some require a much greater degree of heat as Sulphate of Potash

In water Salts are soluble not from a Action of the Water on the Salt but from their mutual action on each other — Some salts attract sufficient humidity from the Atmosphere to dissolve them and these are called deliquescent

Experiments to exhibit this — When Salt is dissolved in water a muddiness is produced by the extricated air — the Solution is accompanied with a change of Temp. generally an increase if the Salt be fluid a diminution if solid — Chemists imagined that the particles of the Salt penetrated between the Interstices of the fluid but the bulk is augmented during Solution the rest in proportion to the bulk of the Salt & of the water taken separately — as was very satisfactorily proved by Mr. Watson — Only a given Quantity of a solid salt can be dissolved in a given Quantity of water and this more slowly as it approaches approaches to Saturation — Water dissolves different Quantities of different salts — from a double proportion as of Potash to that of 1/200 Part as of caudulous Particles of Potash — But as the Temp: rises the proportion of Salt which will be dissolved increases — by knowing this — some Chemists have agreed on a Temp for Solution except where otherwise specified — Muriate of Soda is an Exception being almost as soluble in cold as in hot water

this power of Caloric in increasing the Solution is supposed to depend on the 1st on its diminishing the cohesion and governing the Chemical Attraction or 2d on an Attractive power of its own for Caloric which by uniting forms a new Compound having a greater attraction for the salt than the water by itself

It is a common fact that when water is saturated with one Salt it will unite with a certain portion of a different Salt another Portion of a third Salt &c and when so combined it will take up a further Quantity of the first Salt

Thus Water 1oz will dissolve 3ixxxij of Nitrat of Potash then 3x of muriat of Ammonia and then a small portion of the muriat of Soda after wch it will dissolve a further Quantity of Nitre and then more of muriat of Ammonia

The Compounds in this Case act by their mutual chemical Attraction and Affinities

Saturation is simple when under certain limits of Quantity of either ingredient may be varied at pleasure — as in the Solution of salt and water the salt not reaching itself to certain definite

quantity of the water but being diffused thro
and combined with the whole — Mr Dalton
however is of opinion that in this Case the
Quantities of each of the waters are definite
and that this Compound unites as such
with & not to the water
when Salt is thrown into water it is diffused thro
the whole mass but this diffusion goes on
in a spirit exceedingly slow — To prove
to show this fact — the dissolved salt being
introduced at bottom of the fluid — the cause of
its diffusion and of its slow diffusion is that the
stratum of fluid which is nearly saturated with
the salt have smaller attraction for the Salt
than the stratum above which has no salt
at all dissolved in it — the Saturated divides this
portion with the superior stratum and the
process goes on in this manner till it is
equably diffused or combined with the whole
— but it proceeds slow on acct of the small dif
ference of the attractive powers of the different
strata and of the minute distance at which
Chemical attraction acts
— Salts may be separated from water by increas
or diminution of Temperature

Most Solid Bodies dissolve from water in Solubility
and generally in a sufficient measure of Temp
the Salt remains, & water evaporating
a higher temp however is necessary than that of
the ordinary Evaporation Point of water on account
of the Attraction subsisting between the water
and the Salt

Richard of Berlin has asserted that some Salts
diminish the Evaporation Point of water but this
is very doubtful

The Salt may be kept liquid & solid after
the Separation of the water as Sulphuric
Acid & Nitrate of Potash

— When there is no necessity for carrying the
Evaporation so far we take advantage of the
greater solubility of Salts in a high temperature
and of water being reduced by evaporation to
a due point — the Solution is suffered to cool
— the Salt of course separates generally not
in regular shapes or in the form of powder
but in Crystals of an unknown regular figure
and the Crystals of the same salt always assume
the same form which circumstance frequently
enables Chemists to distinguish one Salt
another — but a similarity in the Crystals of

different Salts by this means
implies any uncertainty in their properties
and it should be remarked that a quantity
separated in Crystallization is not the Salt
which the water contains but merely that
portion which is not soluble in the water at
the ordinary Temperature

It is also in consequence of the separation of Part of
the salt from the water that a pellicle appears on
the surface — but if the Pan is not quite so
full if it be continued till this appears but
the due separation may be estimated by the
specific gravity of the Fluid —

It is also necessary in conducting
this process properly that the liquor should
cool very slowly — One of the finest Sorts
of Crystals I ever saw was a mass of Sulphate
of alumine which had been three months in
cooling — & some of the Crystals were 18 Inches in
length —

After the first deposition of Crystals the
supernatant liquor should be again evaporated
& crystallized — but this is not carried so far
the last portions of the liquor as this generally con-
tains a large portion of Foulnesses & is called

Mother Ley — The largest and finest Crystals are Mained by very slow evaporation or by spont evaporation — and this last plan can be employed to crystalline the muriate of Soda

— The Vessels used for Evaporation, and Crystallizing should be of the globular shape on third of the Globe being cut off. If they are of an inverted conical figure the Attraction of cohesion draws up the fluid to the sides of the Vessels around the surface of the rest of the fluid this elevated circle crystalizes and by its sponginess it draws up the same fluid that a coat is formed over the side of the Vessels which draws up the fluid by capillary attraction and distills it gradually on the outside of the Vessel like a capillary syphon This is called Vegetation

— There are some salts of which if you make a saturate solution in heat and suffer the Solution to cool the saline matter is not immediately deposited but retained in Solution a day or two before this Process commences

— But there are certain means by which if the solution be perfectly saturated the Crystalization may be made to commence in a quarter of an hour — a better method is adding a Portion of the saline body in the form of Crystal

Esp: illustrating this with a solution of
Sulphate of Soda

During this Crystallization of Temp is raised
by from 30° to 51 Degrees — and tho the whole
appears a solid mass of crystals yet the
the salt previously to its crystallization is
here present but it is inhibited by the Spring-
ness of the Crystalline mass

— or if a saturated solution is made in hot
& & be stopped whil it is boiling so that
no air may be in Contact with the Solution
the Saline matter remains suspended tile
an access of air it begins to crystallize
Beautiful Esp. illustrating this

— Crystallization depends on the cohesive attrac
tion between the Particles of the Salt being greater
than the Chemical Attraction between the
Salt and the water

Kirwan has asserted that if a Solution
of 2 Parts of Nitrate of Potash & 3 Parts Sulph.
of Soda be made in 5 Parts of water at 98°
and if a Crystal of the Solution be divided and a
Crystal of Nitrate of Potash be added to one Part
of it Nitrate of Potash will be deposited &
if a crystal of Sulphate of Potash be added

to the other dilute Sulphuric Soda will be deposited — I have tried this but have not succeeded.

When Salts are thus formed into Crystals they unite with a certain proportion of their depositing liquor and this is called water of Crystallization — hence arise many of their Phenomena — as watery fusion — when by heat they are dissolved in their own water of Crystallization — If they are exposed to dryness and the heat be sufficient they are fused in several time This is the true fusion

Many Salts part with their water of Crystallization to the air — This is called efflorescence and is always in proportion to the humidity of the air & air versa — This should be attended in weighing Salts since near half of which is frequently formed in their crystalline state by their water of Crystallization

Some Salts attract humidity from moist air & impart it to dry air

Certain Salts dissolve when suspended what this depends on their containing a minute portion of water of crystallization which is held tenaciously and by being suddenly converted into vapour it occasions with a minute explosion

Another mode of separating the Crystals of Salt

from the boiler is by reducing the Solution to a point so low that the water may be frozen — this temperature according to the nature of the Salt employed — Muriate of Soda dissolved in water requires that the Solution be reduced to an 4° made to this Effect — and generally it is requisite to reduce the point to that point which is produced by mixing the respective Salt dissolved with snow —

It depends also on the Quantity of Salt dissolved in proportion to the Quantity of Liquid — Thus Sir Chas Blagden maintains that if a solution of ℥j of Salt frozen in ℔j of water freezes at 28° a Solution of ℥ij in ℔j will freeze at 24° of ℥iij in ℔j at 20° &c

The Cause of Crystallization is not yet decided — but the disposition to form regular polygonal figures is found not only in Solid bodies but in Earths Inflammable Metals &c and the Cause must be somewhat common to them all, and what I say with regard to them may be regarded as extending to all bodies which assume this regular determinate Polygonal form —

The Particles of the Salt acquire this Arrangement and Movement of their separation but it is not necessary to this that they should be deposited

in water provided they are in such a State of fluidity as will allow a free motion and change of Place

Some have that mainly in mechanical dispersion — if the Particles were sufficiently minute they wd arrange themselves into Crystals — but of this there is no proof

If a Salt be deprived by heat of its water of Crystallization & then crystallized the form of the Crystals will not be the same as when united to the water of Crystallization

If the heat applied be sufficient to convert the solid substance into Vapour its Particles will be found to arrange themselves into forms similar to those wh have been produced by Crystallization

As to the Cause of Crystalization —

The Particles unite into masses in consequence of the Abstraction of aggregation — The determinate figure of the Crystal is by some ascribed to the figure of the ultimate molecule and this it can scarcely be supposed that the figure of the ultimate molecule is precisely the same with that of the Crystal yet it is highly probable that the figure of the ultimate molecules in generation of the form of the Crystal

But it will be asked how the particles or molecules
are brought into union at such points as to form
a regular internal Structure
Laplace & Poisson attribute this entirely to
aggregative attraction influenced by different
extent of surface and different sides of the molecule
Mr Dalton and Dr Black were of opinion
that it was owing to a set of Polarity
Dr Spinnie has lately entertained that Galva-
nism has a considerable effect in disposing the arrang-
ement of the particles composing a Crystal
Lastly it remains to explain the Cause why each
different Species of Substance assumes a form peculiar
to itself as a vast variety of different figured might
consist of molecules ultimately the same
It is indeed true that the Crystals of the same Body
are different in their external shape as Bergman
has beautifully demonstrated, with regard to calcareous Spar
but they all contain
a nucleus which is precisely similar - and the
difference in something in the arranging cause which
we cannot explain
We next proceed to the mode of separating Salts
from each other when they are dry or mechanically
mixed with each other in a fluid - If they differ in
solubility this may be done by Crystallizing that which is
least soluble - If they differ in volatility Sublimation

may be employed — if one is delinquent both may be placed in a funnel on tabulous paper — a few more of these methods will answer the purpose both of Salts may be carefully crystallized together and the Crystals of one carefully separated from those of the other —

— Salts are distinguished into simple and compound

Simple Salts are so named not from their being chemical Elements but from their entering into the formation of more compounded salts

Simple or Primitive Salts are Alkalies & Acid ~~or Earths~~ The first order of Alkalies are three in number — two fixed and are called the vegetable or Potash & the mineral or Soda — and one volatile the Ammonia

— Alkalies are remarkably active bodies — fusible in the fire soluble in water with steam and of a pungent sharp disagreable acrimonious taste — and they change the color of vegetable Infusions — Exp. with an infusion of the flowers of Malva — or rather a decoction of them and with an infusion of red leaves of red Cabbage

The effect is not produced in exactly the same manner in all vegetable Colors — It generally changes pure blues green — purples pure blues reds & browns pure blues —

Infusion of White roses exhibits the same Change as infusion of red roses

Too much Alkali destroys the vegetable matter staining the infusion of blues — &c:

— Alkalies are Stained only by Chemical Proofs

Potash when perfectly pure forms a White dry mass — It admits of being crystallized into quadrangular Prisms — It melts at 360 & may be again condensed to a solid form — it is sufficiently high point it powers volatile & does not undergo any chemical Change as appears when it is decomposed —

It is the most delinquescent of the solid bodies

It is frequently employed to extract the humidity from the air or from gases to which it has no chemical affinity or action

It must be kept in close Vessels as it serves to extract Carbonic acid from the Atmosphere

The dry salt takes half its weight of water to dissolve it & the Crystals contain half

— If perfectly dry Potash be mixed with water

heat is evolved – if the Crystals be used Cold – If mixed with Snow a very rapid & considerable diminution of Temp is produced – of no less according to Lovat than 85½ degrees that is from 30 to m 55½

In medicine Potash is employed as a Caustic to destroy the texture of animal matter which it does very rapidly   It is also given as a Lithontriptic in veal broth

It is employed in Bleaching and in making Soap

It is obtained principally from the ashes of Vegetables – Herbaceous Plants yield it most copiously, then the leaves of trees – shrubby Plants and least of all the ligneous part of trees –

It is disputed whether it be derived by the Vegetable from the Earth or be formed in the Vegetation of the Plant – it exists in the Plant but mode of uncertain – It is found in many fossil substances as Pumice Stone – Felt spar &c & in the Lava of mount Vesuvius

– It is called Lixiv: P. L. & Kali purum by the London College the last is peculiarly improper as the Herb Kali yields the Salt called Soda

– Potash is still considered as a Chemical Elemt

On ye Coast of Spain — & Mediterranean & Caspian Sea Plants are cultivated for ye purpose of Burning Soda — It is procured from ye common Sea Weed in ye highlands of Scotland and the ashes after Incineration are called Kelp. S.H.

Morveau has said that it is a compound of Hydrogen & Earth of Lime but this is merely a random Conjecture

Soda like Potash has an acrid pungent taste is fusible vaporable — deliquescent changed by contact with the air from which it absorbs Carbonic Acid — soluble in water — uninflammable & changes vegetable Colors —

It is the basis of the Nitre of the sacred writings

It is chiefly distinguished from Potash by the difference of Compounds formed from each

It does not exist pure in Nature

It is used in the making of Glass and of Soap

It is the base of what is vulgarly called Soda or Barilla

It is procured from certain Plants and is found in some Lava & other mineral Substances

It must be carefully distinguished from the Carbonate of Soda

As yet it is considered as a Chemical Element tho Morveau has endeavoured to show that it is compound of the Earth of Magnesia & Hydrogen

— Ammonia or volatile Alkali when perfectly free from foreign matter appears in the form of a gaseous permanently elastic compressible fluid.

This has been called Alkaline Air — Its Specific Grav is ,596 — a cubic Inch weighs one eighth & half of a grain — It is powerfully irritating to the Eyes Nostrils and Lungs

When exposed to a high Temp a remarkable change is induced and it loses its alkaline properties It cannot be endured but unites instantaneously with water

Exp. a Vial being filled with this Alkaline Air & Ammonia is a pure State — was immersed in an Infusion of Red Cabbage — the Liquor being taken out under the surface of the Infusion & Infusion filled the Vial in an Instant & was changed to a bright green color by the alkali which had united with it

The water in this Experiment assumes all the qualities of the Ammonia — Water absorbs about half its weight Ammoniacal Gas

Specific Gravity of Water so saturated is ,880

The odour of this liquid Ammonia is extremely pungent — if raised to a Temp of 95 its odour is almost repressed — it begins to crystallize into needle like spicula and on 63 it undergoes completely or actions it to the ordinary temp & against pressure and if the Temp be increased the Gas

is quickly becomes much more powerful ——
at a sufficient Temp it passes into a State of Elast
ticity and the vapor disengaged is of ammoniacal
Gas or alcaline air

— This Substance must be kept in Vials inverted
in Quicksilver in a Tube of two Inches & bil may
be applied round the Stopple — if inverted in
water — the water infallibly absorbs the Ammonia
nor can any Stopple be ground so accurately as
to prevent it —

Excepting Ether it is the most volatile of substan
ces and will produce a great degree of Cold by its Evo
poration — If the liquid Ammonia (iron water
saturated with ammonia — as it is called with
ammoniacal Gas) be placed under an exhausted
Receiver it quickly boils —

When ammonia enters into a Atmosphere
it combines with a substance to be afterwards
mentioned (carbonic Gas) and its properties are
changed

Ammonia is no longer considered as a Chem
Element — for it has been discovered that when subjected
to a high Temp it is resolved into Hydrogeneous Gas
and azotic Gas — permanently enlarging their
former the space it did before

In this discovery we are indebted to D. Priestley and Scheele.

One mode of decomposing & Ammoniacal Gas is by placing it a vessel mounted in Quicksilver & a vessel it should not fill more than ⅓ and then passing successively electric sparks through it

The other mode is by causing Ammoniacal gas to pass thro an heated earthen tube of Wedgewood manufacture, heated to a red heat — In the tube small pieces of earth of a similar kind are placed to increase the effects as the Gas strikes against them when passing thro' the tube.

Esp to exhibit this

The process must be carried on slowly and heat with not be sufficient to decompose Ammonia the Mixed Gas is collected in an inverted bell placed in water one of extremely fine earthen tube — this product is found no longer to possess the properties of ammonia but it has gained others viz those of a mixt of Hydrog & azotic Gas

According to Berthollet the Proportions of these Ingred. in Ammonia are by measure 2 of Hydrogen to 1 of azot or 1,725 to 1,375 — but the Proportions by w.t are 2 of Hydrog to azot 121 or 193 to 807

Ammonia cannot be synthetically recomposed by mixing together azote and hydrogenous Gas because they are both unfitted for a large portion of Caloric and the attraction between these bases is not sufficient to overcome this attraction for Caloric — But if they be brought into contact when in what is called a nascent state that is if nascent before their conversion into gas — they unite and form ammonia and this effect takes place even if one be nascent and the other Gaseous — Thus e.g. if Iron filings be mixed with water they decompose it unite with it one part its oxygen & the hydrogen is set at liberty — now if over such a mixture a jar be placed filled with azotic Gas, this azotic Gas uniting with the nascent hydrogen forms ammonia

From these experiments it has been imagined that the other alkalies are compound bodies

The Aq: Ammonia prime of the London & the aq: Liquida Cautica of the Ed: Ph: are not perfectly saturated with ammoniacal Gas

— This Substance has been employed externally alone or mixed with oil as a Embrocation

It has been much lauded in Dyspepsia
& is found a most efficacious remedy yet discovered for the bite of some Indian Serpents
as the Cobra de Capello — It is for this purpose used both ext & int Sir James's
Acetic researches

It is used also to smelt to in fainting &
forms the Basis of Eau de Luce

It is sometimes found in the neighborhood of
Volcano's and it is known by the action of
fire and by Calcination from Animal and Vegetable substances — It is also formed by Synthesis in the Combustion of Charcoal

Acids of these there are no less than 27 or 28 —
I shall now treat only of the most active &
leave the rest to a future period when I come to
speak of the substances from w.h they are formed
— They are called acid merely on account of
their acid sour taste — Of these some
are acrid others mild some solid others
fluid & these are called Mineral acids some
are volatile others fixed

And change the color of Vegetables blue
a manner very different from Alkalies —

Exhib: of Exp: with 8 Tinct of Malva flowers
Tinctures of Litmus & Hyperion fed Cabbage
respectively with 8 Sulphuric Nitric & Muri:
Acids by all of which they are changed to a bright
red
And Alkalies have many opposites of which
I shall have to speak hereafter — with Alk:
they generate heat — They have a strong attract
for water and they are separated from it by
it is called Concentration Dephlegmation or Rectification

Sulphuric Acid — so called because its base is
Sulphur — a Nitrick Acid because it is
procured in large Quantities from Nitrid

It is transparent colorless & inodorous
extremely corrosive requiring large dilution
before it can be tasted — Specific Gravity of very
pure strong Vitr: Sulphuric acid is nearly
double that of water — or commonly reckoned
it is about 1850 — from its density it is a
sluggish fluid & hence called Oil of Vitriol
— In a reduction of Temp: it may be frozen as
was done by Bouhaave first afterwards by many
others but this effect took place at very different
Temperatures — M. Chaptal & Kirwan afterwards

found that the Variation depended on the Strength of the Acid — and it was very singular that at a certain Strength when its Sp. Grav. was about ~~1.82~~ 1780. It might be congealed even at 45° but if more concentrated or if diluted with much water like its Strength was diminished a very intense degree of cold was required

— Thus when diluted with an equal Quantity of water it resisted a cold of 90 & was employed by Mr. Walker in the production of that intense degree of Cold —

Crystals of Sulphuric Acid are solids of ten sides had 1/30th heavier than the Sulphuric Acid itself — (differing widely in this respect from watery fluids) — and

The Sulphuric Acid like water below its congealing Temp and then on a slight agitation there is an Evolution of latent Caloric & Acid starts in an instant up to its freezing point when consolidation begins

When of the same degree of concentration it conformably passes from a solid to a fluid and from a fluid to a solid form at one Temp illustrating what was before said of the destruction of latent caloric in the freezing of water and the

the Phenomena exhibited by that fluid with reg.
to latent Caloric when passing from a solid to
a fluid or a fluid to a solid form

By an increase of Temp to 550°. this acid
changes into Vapour - transparent and colourless
gas &c - It may be condensed without any
change of Properties

If a much higher temp is employed a
remarkable change takes place - if it is
made to pass thro an ignited earthen tube
it is converted into an odorous volatile acid
and oxygen is disengaged - the nature of this
change shall be hereafter explained

- If water thoroughly with water producing
a great increase of Temp so as to cause both
to boil an Vapour exhibited and yt result is
found to be greatly diminished in bulk

- If exposed to ye Air it will absorb humidity
from it to a great amount - thus 3j will
absorb 3j in an hour - if left thus exposed
a few days it will absorb its own wt of water
according to M Kirwan It absorption increases in
the ratio of 3d 50 of the quantity of water
- By dilution the Properties of ye acid are not
changed but merely weakened

Water may be separated from Sulphuric Acid by distillation with a heat and a receiver of glass if it be largely diluted a Temp not much higher than 212° (the vaporific point of Water) will be requisite — but as the quantity of water decreases the heat must be increased till it comes by degrees to 550° By this time all of water will have come over mixed with some portion of the acid — but as soon as the Temp is increased to about 558° the acid itself begins to come over and from the manners of the French Academy there is reason to believe that the strongest acid comes over first

The Sulphuric Acid combines readily with water in the form of Snow or pounded Ice and liquefies it with great rapidity — but here two causes counteract each other — by the liquefaction of the snow a great deal of heat is absorbed and becomes latent in it — but by the mixture of the Acid with the water a great evolution of heat is produced so that the Temp of the mixture is almost unchanged — if the Sulphuric Acid be diluted first with about half its weight of water in which snow till the Temp begins to diminish — and

if in this diluted state it be mixed with pounded Ice or with snow – the Temp is very rapidly diminished – if the materials were at 30° – the mixture wd sink to -23° – but by using these materials previously coold by immersion in a mixture of the same kind – the ingredients of wh had also been thus cooled in process succession Mr. Macknab procured at Hudson's Bay a cold of -78½

A still greater degree of cold is produced if instead of using diluted sulphuric Acid in a fluid state it be congealed before its mixture with the snow – Sulphuric Acid with Alkalies forms Neutral Salts of wh hereafter

– It has no peculiar Chemic relation to oxygen or acid wh disposes it to unite with them

A peculiar action takes place between this Acid & inflammable bodies – To illustrate this I shall use a compound inflammable body – the rectified Oil of Turpentine consisting of Hydrogen and Carbon – if a small portion of this be mixed with Sulph Acid – a remarkable discoloration of the Acid takes place – exp

If the Ingredients be mixed in more equal proportions a remarkable explosion is produced and

The vapors have a strong odour of Sulphurous Acid or burning Sulphur mixed with the odour of Turpentine

– From an accidental mixture of a minute portion of some inflammable matter the acid as we generally procure it is of a darkened hue – it may be purified by pouring the acid in a stream of Florence Flask – in a sand bath & by applying a mod^te heat the inflammable substance is separated in the form of sulphurous vapor – and at length if the inflammable matter be of a dense nature as Charcoal Sulphur itself is ~~a standard~~ found to remain after the process

There appears a intimate relation between Sulphurous Acid and Sulphur – for this appears most evidently from the conversion of Sulphur into Sulphurous acid by Combustion

Also exhibiting this by burning of Sulphur in an inverted glass Jar and then pouring into it just an infusion of red Cabbage wch from purple it changes into a bright red

– If this Sulphur instead of a bright white flame burns with a faint Bluish lambent flame the vapors are found to be less condensible & form of Sulphurous acid this approaches to the nature

of the sulphuric acid & may be converted into it

The first & generally received explanation given of these phenomena was that of Stahl — He considered the inflam^n of certain bodies as depending on a principle contained in them wch he called Phlogiston — and imagined that in the inflam^n sulphur converts Sulphur into Sulphuric acid & the Phlogiston is dissipated — and when by a slow combustion it was converted into Sulphurous acid he conceived that only part of the Phlogiston was dissipated by inflammation & not the whole

— But from later experiments of Lavoisier it appears that the Sulphuric acid produced is heavier than the Sulphur itself — and according to the Lavoisian theory — the Sulphur is a Chemical simple and the acid is a Compound — For this Conversion is found to take place only when in contact with air, which requires to be frequently renewed and is wholly during the process, losing its oxygenous parts — and this loss is found exactly to correspond in weight — with the plus weight gained by the Sulphur when converted into the acid of Sulphur

Exp. Combustion of Sulphur in oxygen Gas

to prove the absorption of the Gas — but towards
the end of the process of Sulphuric & Sulphurous
acid generated mechanically prevent the con-
tinuance and consequent absorption of oxygen from going
on. The addition of wt gained by the Sulphur in this
conversion is about 2/5ths — in 100 Parts of Sulphur
from 140 of acid —

If the oxygen be detracted from Sulphuric acid by
the addition of an inflammable body to it (which
detracts its oxygen) the loss of the oxygen wt in this case is
exactly equal to the gain in the preceding

— M. Lavoisier was of opinion that the heat and
light which appears in the Combustion of Sulphur was occa-
sioned by the sudden condition of the Caloric of the oxygenous
Gas when passing from an aeriform to a fluid form

The Stahlians have united to compromise matters
and imagine that Sulphur formed of the inflam-
mable Substance (consists of an inflammable base and
Phlogiston, or the principle of light & heat or wt of the latter
called the solar light and that during Combustion
the inflammable base united with the oxygen of the air
and the Phlogiston was separated causing the Phæ-
nomena of heat & light

— Perhaps this account of the matter may be in
many respects a probable one but the Phlogiston

as here explained is widely different from it was called Phlogiston by Stahl and to avoid confusion the term should be exploded

The Sulphurous Acid is a bisoxygenated Sulphuric Acid + and it is a gaseous transparent fluid It is colorless and has a pungent offensive suffocating odor — its specific Gravity is 2100 — a cubic Inch weighs 11^{gr} 5 grain — It may be condensed by cold and Pressure — and when submitted to a high Temp it is decomposed being changed into Sulphuric Acid & Sulphur — that is the oxygen quits a part of it gas to saturate the remainder so as to form of Sulphuric Acid & that portion w^{h} is deserted by the oxygen appears in the uncombined form of Sulphur

If Sulphurous Acid be moderately heated in contact with oxygen it unites with the oxygen forming Sulphuric Acid

Sulphurous Acid is absorbed by water — and at 32° the water will absorb about a fifth of its own weight with a great increase of Temperature — to 110° — The specific gravity of water thus saturated is less than that of pure water & it has a pungent odour of Sulphurous Acid — It is decomposed by heat — Sulphurous Acid destroys color and this is one

of its most valuable properties

Eff with Tinctures of Litmus but then the Sulphurous acid has caused of Color to vanish it will easily be changed to a red by the Sulphurous acid —

— The Sulphurous acid was known to Basil Valentine in the 15th Century — It is rarely found native it is met with united in some Springs and in the neighbourhood of Volcanoes It exists in prodigious Quantities in the Earth combined with Iron Copper Zinc Barytes Alumine Magnesia Gypsum and it used to be procured from the Sulphate of Iron green Vitriol or Copperas

It is now obtained by the Combustion of Sulphur — The Process for Campanario" as it was called was very unproductive and it is now conducted in our manufactories in Ranges of small Chambers the walls of which are coated with Sheet Lead.

(according to Chaptal a coating of Varnish consisting of Resin Wax & Turpentine would answer the purpose)

— Each Chamber or apartment is about 7 or 8 feet long & of width & height in proportion — They are made air tight during the Combustion & the floor is covered with water in which the acid gases are condensed

— The Sulphur in this process is mixed with 6th or one sixth of nitre that it may burn

with a bright white flame — It is a common mistake to suppose that the oxygen is supplied by the nitre for the conversion of the Sulphur into the Sulphuric acid for this oxygen yielded by the nitre is almost entirely absorbed by its alkaline base — its only use is to determine the mode in which the Sulphur & Brimstone — There are two apertures into each apartment and when three hours have elapsed for combustion & absorption one of these is opened for the renewal of the air — It is loaded by Sulphurous vapours and very prejudicial to the workmen — which might be prevented if an aperture were made in the top of the apartment instead of the side — This process is generally continued about three hours before the water on the floor of the apartments is saturated or sufficiently saturated — and then by evaporation in leaden vessels it is concentrated to the specific gravity of about

In this state it contains usually some traces of Lime Lead and Alkali pure for most chemical purposes it may be purified by distillation

— The Sulphuric acid is extensively used in medicine as a refrigt and antiseptic

The employment of Sulphuric acid in the bleaching of cotton cloth &c is one of the valuable improvements

in modern bleaching — It is used in Tanning — Dyeing to dissolve indigo — in ye separation of Silver from Copper & numberless processes besides

The Sulphurous acid is of great use in whitening woollen and silken Cloths

This Acid has been known by an infinite number of names — by ye French ye fully oxygenated acid is called Sulphuricum — and all fully oxygenated acids are made to terminate in "icum" — and ye acid not fully saturated with oxygen is called Acidum Sulphurosum ~~and~~ and so all other other acids not completely acidified or with a smaller proportion of oxygen are made to end in "osum" — & this distinction is highly useful

Nitric Acid is so called because it is procured from Nitre — when pure it is transparent but commonly it is coloured of a yellow orange or blood red Color — ye Vapors arising are of ye same color with ye Acid from wch they arise — This vapor is very penetrating and offensive to the lungs — — To render ye coloured acid colourless we place it in a retort & adapt a receiver then with a very gentle heat ye volatile reddish part passes off into ye receiver which must be kept very cool — about 3/4 of ye whole remains in ye Retort of ye colourless Nitric acid

a similar Process goes on if ye Nitrous Acid is exposed to ye Air but in this Case the redder Portion is lost & ye remainder absorbs a certain quant. of Humidy from ye Air —

It was found that the coloured Acid could be changed into the colourless & ye colourless into ye coloured and formerly this was accounted for on ye principles of Stahl — ye colourless was called dephlogisticated ye coloured was called Phlogisticated — accordingly ye latter were denominated deficient in oxygen — the colourless oxygenated or saturated with oxygen — the one is ye Acidum Nitricum & other ye Acidum Nitrosum

If a quantity of Nitric Acid be exposed to a bright sunshine a Portion of oxygen is disengaged and the acid becomes of an orange hue

Berthollet has proved that this change is effected by the light and not by the heat of ye Sun by the followg experimt he exposed Nitric acid covered with a strong dark coloured Paper to ye Sun's rays but no discoloration followed —

The acid shd therefore be kept in the dark or in bottles stopped so fast that there may be no room for ye disengagement of oxygen gas —

& Priestley imbibed nitrous Acid in a Gun Barrel and immersed the bulb to distillation but not boiled so that no light could come in contact with the Acid but on removing the Prepared oxygen Gas rushed out & Permanency Acid was found dissolved proving that by an increase of Temperature is changed into Nitrous Acid and oxygen

The Specific Gravity of Nitrous Acid is 1580 — It is the most corrosive of all other Acids. a small drop on the Skin burns it to a yellow Color which does not disappear till the Skin is worn off

— It has been examined by Cobb by Professor Braun of Petersburg and by Mr Kirwan at Londres by order & direction of Mr Cavendish of London —

— But it is found that the freezing Point varies owing to the different Degrees of Concentration — When about 4/10 of its weight of water has been added so as to make its specific gravity 1.3771 — to 1000. it freezes at 11° if more water be added the freezing Point is lowered to 45° —

The Phenomena of its congelation resemble those of water & of sulphuric Acid — for Nitrous Acid of the ~~same~~ Sp: Gravity above mentioned may have its Temp: lowered to 39 before its agitation it starts to 11° and begins to crystallize

It ~~sat~~ diminishes in Bulk during Crystallization the Crystals are slender and of ab^t ½ an inch in length — their precise form is not yet known

— Nitric Acid emits vapours at ye ordinary Temp of ye Air

If the Temp be consid^y increased it is brought to ebullition — and the vapours are condensible unchanged

If Nitrous acid be evaporated water is required for its condensation

But if the Temp employed be more than barely sufficient for ye ebullition and vaporation of the Nitric Acid it is decomposed and resolved into oxygen & nitrous acid

When made to pass thro an ignited earthen tube it undergoes a very remarkable change — losing entirely all its acid Qualities and being converted into azotic & oxygenous Gas. Thus by heat the most corrosive of Substances is found to pass into ye Substances composing the Air of ye Atmosphere but the proportions are very different — according to Lavoisier 79 Parts of oxygen to 21 of azotic Gas — or nearly ten times more oxygen than exists in ye air in proportion to ye azot — accord^g to Mr Davy the proportions of ye Nitric Acid are 70½ to 29½ — in ye Nitrous Acid nearly ye same or 69⅔ to 30⅓. — Exp. exhibiting & illustrating these facts

This is one mode of obtaining oxygen Gas from Nitric Acid -

The decomposition is supposed to be owing to this that the component Parts having there an Attraction stronger for calorick than they have for each other and thus separate in Gaseous form

This fact is one of the most interesting in modern Chemistry but to secure perfect belief the synthetic proof must accompany the analytic — and for this we are indebted to Mr Cavendish of London who found that when atmospheric air was heated by passing the electric spark thro it that it was changed into Nitrous acid — This was discovered by accident when he was making experiments with a very different Intention — It then used an apparatus like the subjoined figure

Let a bent small syphon with its extremities immersed in quicksilver and let it be filled with quicksilver to the Points b.b. — Then to add with alkali & above with nitrous acid & oxygen gas in the proportions of 3 parts of the former to 7 of the latter — Then by passing an electric spark thro the syphon these gases are changed into nitrous acid which combines with the alkaline solution

It is a singular circumstance that Substances so different as nitrous acid & ammonia shd have one common base each

We now come to notice a relation which this acid bears to water — It is disposed to unite with it either in the form of steam or in its natural and fluid form — If 4 Parts of ye strong Nitrous acid diluted with 1/2 of its w^t of water or of ye common nitrous modified and be mixed with 7 Parts of Snow — at 32° they produce a cold equal to 30 or — 36 a still greater degree of cold is produced if ye acid is previously cooled — but the maximum of Cold is when these substances can produce it 45° as the acid then unequal and ceases to act on Snow. If Nitrous Acid be mixed with water ye Temp^r is raised to 110 with some diminution of Bulk — If the Nitrous Acid be mixed with water there is a lively ebullition and copious discharge of fumes of a Dark red color —

Dr Murshalling Thin

The Cause of these Phenomena is this — The water having a disposition to unite with nitric Acid but not with Nitrous — when Nitrous Acid & water are mixed together — a part of the Nitrous Acid is by an increase of its oxygen, changed into

If for the same reason if Nitrous Acid be passed over Sulphur or Sulphurous Gas Sulphuric Acid & the Nitrous Acid becomes nitrous.

the nitric Acid — at the expence of the rest of the
nitrous Acid w.h burning of course less oxyg:
in consequence of this deprivation, nitr in the
red fumes or yellow in the vapour.

And the result is a mixture of Nitric Acid
and Water — or rather a combination of these whether
the Acid is deluted be nitric or nitrous

Water may be separated from Nitric Acid
by distillation but a higher heat is required than
w.h would cause the distillation of the Acid in an unmixt
state — for when mixed with water — the result is
less volatile than either of the Ingred.ts The
process must not be continued too long as if nitric
Acid and of strongest Nitric first arise in that
case come over

If nitric Acid be added to sulphuric Acid
w.h has been discoloured by admixture of some inflam.ble
substance, the Sulphurous acid not being fully
oxygenated will deprive oxygen from nitric Acid
& become colorless — while the nitric is converted into
Nitrous Acid red and fuming (1)

All inflammable bodies exert a very powerful action
on this Acid

If a small Portion be added to an inflam.ble substance
a slight heat is produced, if more a deeper heat &

if a sufficient quantity be added and fumes of Nitrous
And acid) especially if assisted by a small de-
gree of heat

exp with Nitric Acid & Alkohol

Exp with Nitric Acid & Oil of Turpentine is at
caused a violent Ebullition and it has caused
a flame if 1/4 of Sulphuric Acid had been added

Then Phenomena are owing to the facility with
which it imparts its oxygen to inflammable Subst

If inflammable bodies be mixed with Nitric Acid
and a gentle heat applied a gaseous fluid called
Nitrous Gas or Nitrous Air of Dr Priestley Among
the inflammable bodies we reckon many metallic Subst
Hence we shall employ it as oxygen

Experiment exhibiting the formation of Nitrous Gas

This Gas has no acid properties whatever Its
Specific gravity is abt 1194 Mr Davy says 1194
and a cubic Inch weighs 0.37 of a grain

It is unfit for Combustion & for Respiration &
Mr Davy is probably the only person who ever tried to
respire it and this possibly in itself it may be in-
nocent but it becomes highly deleterious from the
change it undergoes It is powerfully antiseptic

It is dilated by heat but it may be made to pass

Thus an equated Tube without decomposition

Van Mamun says that by electric Spark it is resolved into Nitric Acid and arctic Gas

Water absorbs 1/10 of its Volume of this Gas —

If nitrous Gas be brought in contact with oxygen Gas they combine and form nitrous acid

Nitric Acid is converted into nitrous Gas by the abstraction of its oxygen which is then instantly combining with the Sugar

Nitrous Gas consists of Part oxygen and Parts arctic Gas — according to Mr Davy of parts oxygenous & parts arctic Gas

If nitrous Gas be mixed with atmospherical air it absorbs its oxygenous Part forming nitrous Acid & leaves the arctic

If Two Parts of Atmospheric Air mixed with one Part of nitrous Gas or 9/10 of a Part of nitrous Gas on water — result that only one Part and a half remained — This is often a very ready way of procuring arctic Gas

If 40 Parts of oxygenous Gas be mixed with 69 of nitrous Gas the absorption of the Gases be perfectly pure & total — and this Property of nitric Acid has been employed first by Dr Priestley to deter

mine the Purity of the Atmospheric air —

The Instrument by wch this is measured is called an Eudiometer and the object of it is to know the amount of the Diminution produced.

The simplest Eudiometer is that of Sausure consisting of a Vial of about 3iss called a Receiver another of about 3j with Stopples accurately ground — these being placed under water & the Receiver filled with water. two measures of 3j each of Atmospheric Air and one of nitrous Gas are thrown into it — & diminution in bulk is ascertained by the quantity of water in the Receiver & this is but ascertained by comparation with in a nice balance. Whatever from the difference of the nitrous gas — the difference of the wet & the nature of the air contained in that vessel with various other Circumstances the results of these experiments are not precise and exact

They are annually repeated 4 or 5 times and an estimate is formed from these mean results.

The nitrous Gas for these purposes may be procured from Copper or Quicksilver & Nitric or nitrous acid diluted these may be placed in a bottle with a perforated Stopple the perforations being so small that while they suffer the Gas to escape into a receiver placed above

but will not suffer it to return to purity & bottle —

— Sir Davy has denominated this Gas oxyd of azot — as it is the wish of the French Chemists to express by the name the understood of the substance — and they have given the name of oxyd to those substances which consist of a base united to a quantity of oxygen not sufficient to convert it into an acid — But there is another substance of a sonorous & different nature to which Mr Davy has given the name of oxyd of azot, and the substance we have now been treating of commonly retains the name of nitrous Gas

The nitric Acid & the Nitrous acid are very rarely found pure in nature tho it is said that some trees of them may be detected in Rain water & snow

— It has been formed synthetically by a few individuals and it is formed also from a combination of its constituent parts during the corruption & putrefaction of animal substances — This led Mr Mitchell of New York to consider it as the original cause of Pestilential Fevers but Nitrous acid is chiefly procured from the Nitrate of Potash — and afterwards purified

This Acid is of great use in Pharmacy Medicine and the Arts — It has been very successfully used by Mr Cammichael Smith & some have recommended it

by many others to correct or destroy the virulence of contagious Effluvia — a fact wch appears to confute at once the opinions of Dr Mitchill

It is used as a Caustic or Escharotic

It was recommended in the Lues Venerea by Mr Scott of Bombay and experience has proved that it possesses considerable powers in that Complaint tho they are not equal to what some have alledged

It has been employed in Herpes Visceral Obstructions & Chronic Rheumatism with good Effect

It is used in Etching, in dissolving & purifying Gold, in making Pigments & for many other purposes

— It has been known only in the form of Nitrous Acid till within these 12 or 14 Years. According to its base it shd have been called azotic acid but azot being considd as a name not the most approp. for the substance it was intended to denote — The French Chemists have retained the name of nitrous acid when this Acid is in the orange cold state calling it when pure nitric Acid

Muriatic Acid so called because extracted from sea salt — Is generally met with in a fluid form, but if freed from water & heterogeneous matter it assumes the gaseous form — It is rarely found of a straw or

yellowish Color but when pure it is colorless

It is less corrosive than either the Sulphuric or Nitric acid — It emits fumes when uncorked which grow white from a Combination they form with the moisture of the air by which combination a degree of heat is generated

Its Specific gravity is about 1170 but Kirwan states it at 1350 & says it may be procured of Sp. gr of 1500

The effects of a reduct.n of Temp.e on it to a great degree of cold are not ascertained

By heat it is volatilized & may be reduced in a gaseous form having all the mechanical properties of atmospheric Air

Exp. exhibiting this —

It must be collected over mercury as it is rapidly imbibed by water exp. and the vessel being of a vegetable blue changed to red

The vol.s of this Gas & water nearly as 2 to 1 and a cubic Inch weighs about 0,5 of a grain

According to Kirwan one grain of water with about a cubic inch of this Gas that is 253 times its own bulk and 9/10 of its weight forming a Muriatic Acid & Sp. gr. of wh. is 1500

The muriatic Acid in its fluid form is merely water united to this Gas

when 5 Parts muri. acid & 27 Parts of Water at 32°
are mixed — The Temp. sinks to — 27

When Muriatic Acid is mixed with water there
is a slight increase of Temp.

It may be separated from water by Distillation —
the acid being left in the Retort but if there pro-
ps. be increased beyond a certain point then
acid itself will come over

Of its relation to oxygen Gas I shall speak here-
after It has no relation to azotic Gas or Hum.
action with it

Its Phenomena when mixed with inflam. bodies
are very diff.t from those of Sulphuric & Nitric Acids
&c.p. the acid loses of a dark color & Thickens
its volant action — The modern Chemists in general
endeavour to account for this by saying that the
base of M. acid abstracts its oxygen so forcibly
that it will not impart it to inflam. substances
— But here I must remark that we have no proof that
muriatic acid is a compound Body and this is sup.d
merely from analogy for we are unable to decompose
it — M.r Henry enquiries that it consists of Hydro-
gen and oxygen — M.r Berthollet supposes it to con-
sist of oxygen united to a compound base of azot
and hydrogen — but to suppose it is at yet a Chemical
Element

Its action with alkalies will be noticed hereafter

2 Of muriatic acid to be mixed with sulphuric an apparent action goes on between them

This is caused by the strong affinity of the sulphuric acid for the water with which the muriatic acid is united & muriatic acid is disengaged in the form of gas

Equal parts of muriatic & nitric acids form aqua regia — late chiefly the only known solvent of gold — Exp. shewing the effects of mixing them and nitric acid becomes of a dark color from the loss of its oxygen — and consequent conversion into nitrous acid — and muriatic acid is disengaged in a peculiar state of condensation

This acid is not found native the muriates & borates have been found it is said in Seas & Rain water — It is found in great abundance in the salt

In medicine it is applied to scaly tumors & used as a detergent in Gargles — It has also been employed to correct nervous affections —

It is extensively used in Pharmacy

It is used in cleaning gold — bleaching linen taking out stains — eroding anatomic Exp.ts &c

Thus and by uniting with oxygen forms with

is called the oxygenated muriatic acid – The mode of procuring this union will be pointed out particularly hereafter at present I shall only observe that one of ye easiest methods is by adding to ye com acid 1/3 or 1/4 of its weight of ye black oxyd of manganese & by applying a gentle heat it will rise in ye form of a Gas of a rich orange Color called the oxygenated muriatic Gas – This Gas is injurs to ye lungs highly pungent & possesses ye mechanl properties of atmospherical air – If the Temp. be reduced to 32 and it be in contact with moisture it condenses or congeals into a crystallized form but this does not take place if it be perfectly dry – but on restoring a somewd higher Temp it reassumes ye Gaseous form

– Water absorbs this Gas but in far less proportion than the common muriatic acid gas – for at 32° it absorbs only abt an equal bulk & if at a high Temp none at all

– with water it forms a yellow or orange colored fluid – wh is ye oxygenated muriatic Acid

This is decomposed by light – oxygenous Gas escaping & ye com muriatic acid being left – it should therefore be kept in ye dark and in full bottles

Its taste is not acid but austere — It destroys entirely vegetable and some mineral Colours

Exp. with Inf. of red Cabbage & with ye same Inf. after ye color had been changed by acid — by alkali

It seems curious that a substance containg a large quantity of wt we consider acid acidifying cause should manifest properties so different from wt are traced in the other acids but ye reason is that the oxygen is very loosely combined with the acid — and combining with ye colouring matter destroys its colour altogether

It has no particular action with oxygen acid

If many of ye these substances denominated inflammable be thrown into ye oxygenated muriatic acid Gas they inflame

Scheele of Sweden who discovered this acid called it the aerated muriatic acid Gas — The English Philosophers denominated it dephlogisticated — and ye French Chemists dephlogisticated

Phosphoric Acid — This is commonly found liquid — but when pure it is in a concrete form — has some taste — changes vegetable Colors — is not corrosive ∴

It is concreted by heat & if the Heat be sufficiently increased it melts into a vitreous substance,

called Phosphoric Acid Glass — It is transparent
& when pure colourless — Its sp. Gr. is to that
of water as 3. to 1. It is very easily broken —
— The concrete phosphoric acid ~~[illegible]~~
has an affinity to water & becomes deliquescent
in the air of the Atmosphere, the Glass deliquesces
more slowly

It has no particular relation to oxygen or azote
with different matters it has no action at a
low Temp. but if the Phosphoric Acid be reduced to
a concrete & dry state & mixed with Carbon —
— and a gentle heat be applied the Carbon disappears
being united to the oxygen of the Phosphoric Acid &
rises in the state of carbonic acid Gas
— Phosphorus by burning produces the Phosphoric
Acid as Sulphur by its combustion produces
the Sulphuric Acid — and the portion of oxygen
gained by the Phosphorus in this Process is equal
to 1½ times its own weight
Its relation to Alkalies comes to be noticed hereafter
with Acids it produces nothing interesting

~~&~~ It exists in large quantity in the Earth of
Bones and this is the source from wh. both —
the Phosphoric Acid and now the Phosphorus itself

are procured It is employed in Chemistry and in Pharmacy but not yet in the Arts

It may be combined with a smaller Portion of Oxygen and it is then called ye Phosphorous acid

Acetous Acid This when pure is transparent and colourless – its smell and taste are grateful and it is not corrosive

It is exceedingly various in ye degrees of its concentration but usually very much diluted – & it may be procured of 5 times its ordinary strength – by processes to be mentd. immedy

As to effects of a reduct of Temp – It freezes at 28° or properly speaking ye water freezes only and this is one way of concentrating ye acid but it is an unfrugal one as much of ye Acid is imbibed by ye spongy texture of ye Ice

If ye acetous acid be stronger than usual a greater degree of cold is requisite, to a certain degree of concentration of the acid – after ye acid has acquired this concentration a slighter cold will congeal it and ye strongest acetous acid congeals at abt 50 – 60° – forming beautiful long prismatic Crystals

If a modt heat be applied it rises in ye form of

vapour and may be rendered unchanged by great
heat be applied it undergoes a remarkable change
and at a high heat it is inflammable
exp. exhibiting its inflammability
This affords an exception to a part of the spirit
of salin bodies — inflammability — during
this combustion it enters into new combinations
and is entirely changed
It is miscible with water but not easily sepa-
rated from it — One mode of dilution —
If com vinegar be distilled the first ⅓ of the liquor
running over is water — The two fourths following
are much stronger and fit for use — the ¼ remain-
ing of fixed matter & colouring matter
mixed with acetous acid — So that half the original
quantity is obtained of pure acetous acid —
it is however very largely diluted with water
Another mode is that of pouring the water on the
mixture, a still more effectual way is after
the acid has been concentrated by two distil-
lations & dilutions — to mix with it a
quantity of Charcoal dust which absorbs the
volatile fixed acid — so that when heat is applied
the water ascends first — ℔j of pounded Charcoal

is requisite to obtain 3x of this concentrated and pure acid

A more simple mode of obtaining it is by decomposing certain Salts containing it — Ex. the acetated Potash.

The metallic Salts Cudgrin affords this acid in a peculiar state — of greater pungency & activity and more penetrating — called radical Vinegar or acetic acid — This contains it is said a large portion of oxygen and I think this is true the same of the French Chemists contend that it differs only from acetous acid in being more concentrated. It is not corrosive or in other words it has no disposition to unite with constituent parts of an animal body.

It has no disposition to unite with oxygen & no action with acids

It has no action with inflammable matters

It's base consists of ordinary constituents of vegetable bodies — Carbon and Hydrogen

It is produced by fermentation — exists ready formed in some vegetable juices

In medicine it is used as an antiseptic and refrig[t] and in cases of obstinate Hiccup — This

It is used to arrest the Effluvia of putrefaction from wounds and sanious discharges employed as a diuretic

It is used in some Pharmaceutical preparations

In Arts it is employed for making white lead — Dying &c &c

Tartarous Acid — The Tartarous acid has not been discovered —

This is obtained from the Tartar of the grapes or inside of casks of wine particularly and Wines of the Rhenish

It consists of Prisms of 6 sides terminated by a wedge — It resembles the acid of Lemons

It is soluble by heat in its weight of Crystallized acid by an increase of heat it becomes changed in its properties

It dissolves readily in water It is not corrosive — It changes the Color of Vegetable Infusions

It may be separated from water by Evaporation but if the Temperature is much higher than 212 the properties of this acid become changed —

It may be evaporated to dryness in a retort by discontinuing the process before it begins to form it may be crystallized — Its

Its Base or Radical is Carbon & Hydrogen —

and this we shall find to be the radical of a variety of vegetable acids — differing in the proportions of the constituents of this compound radical — viz Carbon & Hydrogen — and differing also in the proportion of oxygen united to the radical

The Tartarous Acid is employed in Medicine & Pharmacy

Boracic Acid. This appears in the form of small flaky Crystals smooth slippery shining and soft — It is the weakest of the acids scarcely impressing any sense of sourness in the mouth — but dissolving slowly & tasting somewhat bitter — By increasing its Temp it undergoes Aqueous fusion — and if fused with air on the water of Crystallization carrying away a Portion of the saline matter — & residuum forming a viscid matter which on cooling concretes into a mass of a glassy appearance

It is a powerful flux of Mineral bodies

The Part of it which has been volatilized does not differ from the Portion — It retains strongly its water of Crystallization but not easily with any more water, according to Bergman only 183 grains of it are dissolved in 1 oz of boiling water — most of which

is deposited on cooling — It changes vegetable colors a little — It has not action with azot or oxygen — Its action with inflam: bodies has not been exam^d.

It is disputed whether it is a compound or a simple body — Mr Craig contends that one of its ingred^ts is an inflam: matter convertible into Charcoal — Tinges the flame of bodies of ~~colour~~ a fine green Color Esp. with alkohol in wch it had been dissolved

It is native in some of the hot springs of Tuscany and in the lakes of the same Country

It is commonly extracted from Borax.

Homberg discovered the acid of Borax and imagined that it was possessed of some valuable sedative qualities but it has not supported its reputation

Carbonic Acid This is the most feeble tho' the most interesting of the Acids — from its extensive diffusion and its share in Chemical operations

The ~~liquid~~ carbonic acid was first properly explained as to its nature and properties by Dr Black in 1769 when demonstrating the cause of the causticity of Lime and alkali When pure it is aerial and it was accounted the air of the atmosphere changed

Van Helmont, called it Gas Silvestre. Dr Hales denominated it fixed Air — a name wch Dr Black

This was the first air found to be different from
the rest of the Atmosphere by Dr Black — a
discovery which paved the way for the modern dis-
coveries in pneumatic Chemistry

In 1776 M. Lavoisier proved that it consisted of
Carbon ~~and Oxygen~~ and Oxygen

It is generated during the combustion of Char-
coal and forms a transparent aeriform fluid —

Its specific gravity is as 1527 to air at 1000

One cubic Inch weighs 0,45 of a grain

It is unfit for respiration and proves fatal not on-
ly by excluding the Air of the Atmosphere but by
its own pernicious qualities and sometimes the
Epiglottis spasmodically denies it entrance into the
lungs

It will not maintain combustion — 2dly.

Being considerably heavier than ~~ordinary~~ the
Air of the Atmosphere it may be poured from one
vessel to another as steadily performed — as poured
on a candle so as to extinguish it

By cold it is contracted in bulk but cannot be
condensed by cold or pressure in any degree as has
yet been tried

By increasing its temp from 32° to 212 it expands

to double its former bulk according to Dufrenoy but suffers no change in Quality

Water at 40° absorbs a little more than its own bulk of this Gas or about 1/50th part of its own wt. If it be at a high Temp. as 50° less is absorbed

This absorption takes place but slowly and is expedited immediately by agitation & pressure

In this state it is called liquid carbonic Acid — Has a sharpish and moderately pungent but a grateful taste — The carbonic Acid is not strongly retained by the water for it is separated by reducing the Temp. to 32° or by increasing it to the boiling point

This Combination is formed between and forms the Ba. Pyrmont & Selters waters — M. Browning of Islington shewed that they owed their acidity to Carbonic Acid and M. Cavendish shewed that they might be prepared by art

This combination of water with Carbonic Acid Gas is extensively used as a Medicine and more so as a pleasant Beverage

It is prepared by dashing of carbonic Acid from marble Chalk &c by the addition of strong Acid as the Muriatic or Sulphuric & causing the

brought into contact with a body of water to be impregnated after having the absorption by agitation purposes

The most elegant apparatus for this purpose is that of Dr. Nooth consisting of 3 Parts

In the lower part is placed the Chalk & the Sulphuric Acid of each about 2 lbs or 3 lbs. & Acid being properly diluted, the middle Part containing 8 lbs of water & by the Combined Acid discharged from the Quantity of Chalk before mentioned this portion of water becomes saturated in 2 days if set within a cool Place — If heat is required & prompt may be accelerated by occasional Agitation

When the water is saturated it should be drawn into Pint Bottles well corked laid on their side & kept cool

Water sufficiently impregnated for many purposes may be obtained in a very short time by agitation

Those who prepare it in the large way have Vessels of Lead to contain the Chalk & the Sulphuric Acid — & ranges of Woulfs bottles & of tubes perfectly air tight connected by tubes so as greatly to increase & promote — forcing the acid thro' an immense weight of water greatly increasing its absorption

ed. The liquid thus impregnated with carbonic acid has
the properties of an acid

Exp. with Tinct of Litmus

I by exposure to the air or by boiling you
expel the Carbonic acid from & Tinct of Litmus
the blue color returns

The Carbonic acid either in a liquid or a
gaseous form is powerfully antiseptic —
Meat will keep much longer when washed with
this carbonated water without growing putrid &
may be restored by it to sweetness after putrefac-
tion has begun

It has no disposition to unite with oxygen
or acid

It has no action with inflammable substances
the reason of which shall be explained hereafter

It has no action with acids

It is the most diffused of all the acids
existing in profusion in the Bowels of the Earth
united to & combined with Lime Barytes Stron-
tian &c It is found in some instances uncom-
bined as particularly in the Grotto
del Cani at Naples which has been known ever
since the days of Pliny — It has derived its name
from proving fatal to dogs — The reason of which

the Carbonic acid Gas extends higher than the mouth of the dog tho by its specific gravity it descends below that of a man in an erect posture

Dogs when nearly suffocated in this Grotto are recommended by throwing them into a neighbouring lake

It is presumed that the Carbonic Acid issues into this Grotto from a subterraneous volcano

This Gas is also found pure in W.ª and called Choke Damps

It exists in the Air in the Proportion of from 1 to 2 per Cent. and it is still a controverted Point whether it should be considered as a necessary or accidental ingredient

That it is necessary is inferred from its being always found, & not only in the Air of the plains & Valleys but even on Mount Blanc the Pinnacle of Europe

That it is merely an accidental ingredient is inferred from the multitude of Operations which are constantly mingling it with the Atmosphere

One of the sources producing this Gas is Respiration — Priestley changing the Color of the Paint of Women's cheeks by blowing thro it to a red tinge

This production of Carbonic acid in animals is owing

to a combination formed between ye Carbon probably of the Blood and the oxygenous Principle of the Air

Another source is ye Combustion of ordinary fuel for carbonic Acid is not generated in all Combustion

Esp. with ye Paper [illegible] or more strictly speaking the Gas proceeding from burning coals — Candle extinguished — Tinct of Litmus reddened.

Here the carbonaceous principle of ye Fuel unites with ye oxygen of the Air forming carbonic acid

But ye Gas resulting from this Combustion contains a large portion of ~~Carbonic~~ Azotic Gas and this is a ready way of procuring azotic Gas if the carbonic acid Gas be detracted by such substances as will absorb it — particularly lime water

a third Source is Fermentation — hence ye injury to Brewers and Others who inspire ye Gas hovering over Vats of fermenting Liquor — It is this Gas which imparts the sparkling beauty to fermented liquor — and to procure this beauty it is only necessary to bottle the liquor before ye fermentation be over tho this may endanger ye bottles

The putrefactive Fermentation is also a source of this acid Gas

It is useful for respiration and it is therefore prudent to try every respirable situation with a candle or lamp before you enter it.

It is used in Medicine in a form of liquid carbonic acid and sometimes in a Gaseous form as an effervescent draught

It is employed as a gentle stimulant and an antiseptic sometimes too as a lithontriptic it is applied externally to alleviate Pain in Cancer

It has been proposed as a remedy in Consumption when inspired via the pulmonary arteries

It has been called Gas Silvestre — fixed air — fixable air, aerial acid — mephitic gas — Chalky and calcareous acid — & was carbonic acid

Compound Salts are those consisting of what are called in contradistinction simple saponaceous Salts combined together

— This Combinat does not take place between all different Salts, nor between Salts of the same acid or two acids or two alkalies —

Every acid has a strong disposition to unite with every alkali — but this disposition is much stronger with regard to one alkali than another or every alkali it may be said has a strong dis

disposition to unite with every Acid but a far stronger disposition to unite with some Acids than with others — During this process a change of property is produced —

This Process is attended with an increase of Temp

— Exp with Aq: Kali & Sulphuric acid very slowly mixed — great heat & ebullition

— Each Portion of the Acid added to ye alkali in this exp attaches itself to and unites with a certain specific Portion of the Alkali and ye remaining alkali remains ye same as before ye addition of acid — if more acid be then added this attaches itself to a Portion of the Alkali in ye same way till by adding a sufficient quantity of Acid both the Ingredients are saturated or that is the whole of ye acid unites with the whole of the Alkali —

The Compound formed by this union is totally different in property Taste [illegible] odour & Effect from ye component Parts — This is called neutralization

— That neutralization is complete may be determined by Test Papers i.e. Paper tinged with vegetable colours — In manifesting the excess of alkali — the infusion or [illegible] ye expressed juice of

the Malva-flowers & of the flowers of the sweetscented violet may be employed — To detect Acid the juice of the Radish Acid of the Root of the Radish — or a Tincture of Litmus or an infusion of petals of red Cabbage may be used to stain of Test Papers

— If a neutral Salt is to be examined it is generally necessary to be very nice in hitting the exact point of Saturation for the redundancies either of Acid or Alkali remains membined in the supernatant fluid

— How many atoms of Acid may saturate any quantity of atoms of Alkali or in other numerical proportions these particles we cannot pretend to tell — and it may be determined by probable proportions in which they unite — as it is difficult to procure the Acid & Alkalies in a perfect State of purity and hence different writers have stated different proportions I shall follow those of Kirwan

In some Cases Salts unite combine in two or more proportions as proportions and Acid & Spirits then a Quantity of Potash combined with a Spirit Quant of the Tartarous Acid forms — the Tartrite of Potash or soluble Tartar — if the Acid be united in a certain quantity of Spirit Vapour it is called acidulous Tartrite of Potash — In such Instances

ye acid generally is in excess and such Salts are generally denominated acidulous – some times ye alkali is in excess & then are called alkaline but shd be called "alkalinous" – The attraction in these cases is stronger between ye the portions of ye neutralized ingredients – than between *these* and ye portion of ye Ingredient that is in excess

By means of these Principles those who deal in Saltpetre Barilla or any other of ye acids or alkalis may have a test of their strength, by ascertaing what quantity of a Salt of ye opposite kind whose strength is known is necessary to saturate any given portion of ye Salt wch they wish to examine and this is a matter of Importance to Soapboilrs bleachers Chemists Dyers &c

Of the compound Salts few are formed by direct actual Combination, Many are produced by nature – and many others by decomposition in processes instituted with another design

These Salts are called compound – or neutral & they have sometimes been called middle salts from a supposition – that their properties were intermed: between the substances of which they were composed but this Idea is erroneous – for the Compound have no pro-

Properties of the said of the alkali — Each of the Ingredients however may be severed from the Compound with all its former relations & attractions unchanged — may they exist unchanged even in the Compound itself for Combination does not destroy attraction and if a third substance be added for either of the Ingredients has originally a stronger attraction than for that with which it is already in Combination — leaving the last it will unite to this third substance

— As the attraction subsists only between acids and and alkalis and as every acid has an attraction for every alkali it will follow that the three alkalis Potash. Soda & Ammonia may form in Diff.t Combinations with the eight different acids I have enumerated 24 Compound Neutral Salts as in the annexed table

When combinations are formed they may be dissolved by different means — some times by heat but more commonly by the elective attraction of one of the Ingred.ts of the Comp.d that is when there is a greater attraction between one of the Ingred.ts of the Compound & some third body than between this said Ingred.t of the Comp.d & that body with which it is already combined

A Table of the different Compound Salts formed by Acids & alkalies

	Acidum Sulphuricum	Acidum Nitricum	Acidum Muriaticum	Acidum Phosphoricum	Acidum acetosum	Acidum Tartarosum	Acidum Boracicum	Acidum Carbonicum
Potassa	Sulphas Potassæ	Nitras Potassæ	Muriás Potassæ	Phosphas Potassæ	Acetis Potassæ	Tartris Potassæ	Boras Potassæ	Carbonas Potassæ
Soda	Sulphas Sodæ	Nitras Sodæ	Muriás Sodæ	Phosphas Sodæ	Acetis Sodæ	Tartris Sodæ	Boras Sodæ	Carbonas Sodæ
Ammonia	Sulphas Ammoniæ	Nitras Ammoniæ	Muriás Ammoniæ	Phosphas Ammoniæ	Acetis Ammoniæ	Tartris Ammoniæ	Boras Ammoniæ	Carbonas Ammoniæ

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the alkaline Ingredt is frequently called the base of the Salt simply because the alkali is frequently in a solid form & the acid almost always liquid but the acid is in reality as much the base of the alkali as each Ingredt contributes in an equal degree to the formation of the Salt

Sulphate of Potash — In the union of the Ingredts forming this Salt there is an increase of Temp — It is transparent hard & solid — The Crystals being prisms of six sides terminated by pyramids of six sides — have a saline bitterish taste and do not deliquesce in the air of the Atmosphere

100 Parts contain of Potash 55 Sulphuric Acid 45, Hassenfratz

of water 0 of Potash 52 Sulph: Acid 40 Berthollet Bergmann

Of these two it is probable that the Calorick of Steam is most attracted as this Salt loses nothing of its wt in a red heat

When exposed to heat it decrepitates — if urged with a strong heat it fuses but was again to a pale mass but suffers no change

It requires 10 times its weight of cold & 5 times its weight of boiling water to dissolve it

It may be procured by evaporation either to dryness or so as to form Crystals —

the largest and most beautiful Crystals are thus formed by spontaneous evaporation

An acidulous Sulphate of Potash may be formed - by an addition of ⅓ part of Nitric Acid to the desired Salt & crystallizing it This Salt differs from the Neutral Sulphate of Potash in being more acid & more soluble in water

It undergoes no change in the Air and the excess of Acid is obtained after many successive Crystallizations but it may easily be dissipated by placing the Salt in a Crucible & applying a strong heat - This Salt may be formed with even a little greater excess of Acid - This Salt so formed is deliquescent in the Air and retains the Acid

The Sulphate of Potash has no action with Oxygen nor of the Inflammable bodies - Charcoal & such substances as contain it produce a great change in the Salt

Mix Sulph. Potassa 2 Parts and hang of Charcoal powdered 1 Part - Subject them mixed to a red heat, it is not necessary that they should be brought to such a heat as to melt the salt, when the operation is over a mass of a dark color is found to remain in the Crucible consisting of Sulphur united to Potash or the Hepar Sulphuris

Sulphuret of Potash – In this process the Charcoal
uniting to the oxygen of the Sulphuric acid flies off
in the form of Carbonic acid Gas – and leaves the
base Sulphur – united to the alkaline Ingred.t

This is an economical mode of procuring the
Sulphuret of Potash

as to the decomposition of this Salt we may observe that
it appears from the foregoing Tables and other aid the alkali
can decompose it for it stands first in the highest row of Column
– Black affirmed that he decomposed it in the Palm of
his hand – his mode was to mix Charcoal with it
& subject it to heat in the former process and when
he had obtained the Sulphuret of Potash he decom-
posed it in the Palm of his hand by adding acetous
acid w.ch uniting with the alkali precipitates the
Sulphur and the acetous acid may be driven from
the alkali by a strong heat

This Salt may also be partially decomposed
by adding addition of certain acids w.ch have a
greater attraction for the Potash than the Sulphuric
acid has – but this is a Phenomenon I shall more
fully explain hereafter

There are also some Earthy bodies w.ch have been
lately found to have the power of decomposing this

Salt but a cheap & easy way of performing it is a Desideratum which might prove a source of great Emolument to the Discoverer

Stahl's mode is infinitely too costive for manufacture

Ld Dundonald has a Patent for its decomposition — his process consists in mixing together Sulphate of Potash & Sawdust, or burning them together (Charcoal) and subjecting them to heat. a Sulphuret of Potash is produced — This is again subjected to heat till a Portion of the Sulphur is dispersed

The Process however does not answer expectation

— another mode consists in mixing 100 of Chalk — 100 of Sulphate of Potash 50 Charcoal These are heated till melted — the Sulphur produced unites with the calcareous Earth — forming an insoluble Compound & by throwing the whole into Water a solution of the alkali is obtained

— At Preston Pans and some other places of Brit^n instead of Chalk Iron filings are added and the Pyrites are calcined into a matter resembling the Spanish brown

The Sulphate of Potash exists in many vegetables juices and may be extracted from their ashes —

It is found in the Earth in Spain — but its

principal Source in the Combination left after the distillation of the Nitric Acid.

It is not used in the Arts but sometimes employed in Medicine as a Laxative or an Alterant,

By the French Chemists it is called Sulphate of Potash as they wish that every Salt in wh the Sulphuric Acid is an Ingredient shd be denominated Sulphas — & then by adding ye name of the Salt to wh it is united an idea of ye Comp of the Salt is at once conveyed by the term Sulphas Potassæ. when any acid ~~is~~ in a less oxygenated state is a part of a compound Salt it is made to terminate in "is" — thus Sulphis Potassæ or Sulphite of Potash at once conveys the nature of a salt formed from ye Sulphureous Acid combined with the Potash

— Bergman in his Nomenclature made the Alkali a Substantive & ye Acid united to it the adjective & this was ye Idea adopted by the Compilers of our Pharmacopœia; ye Ed: Ph: denominates this Salt. Lixiva Vitriolata — In the L Ph: it is called Kali Vitriolatum — Kali being ye name the London College chose to give to ye fixd Vegetable Alkali — & Lixiva the name ~~at~~ used by ye Ed. College

Sulphate of Soda - commonly called Glauber's Salts from a celebrated German Chemist whose name has been given to this and many other chemical substances. Its Crystals consist of Prisms of 4 or 6 sides terminated by two 4 sided pyramids by 4 converging Planes

Its taste is bitter saline & disagreeable

It effloresces in the air & loses its water of Crystallization and consequently its weight in a considerable

100 Parts contain Water 58. Soda 18½ Sulph. Acid 23½ and Mr Thomson Bergman computes that 100 Parts contain 58 of water 15 of Alkali & 27 of Acid

If thoroughly dried it consists of 46 Parts Soda & 54. Acid

In heat it undergoes first the watery fusion - if the heat be continued the water is dissipated leaving the Salt in a powdery form - and if it continues it undergoes a real fusion but without Change

Water at 50° dissolves of its weight boiling water an equal weight, Some moisture is requisite in order for the Salt during its liquefaction to produce a great degree of Cold - and if cooled - the evaporation Point is higher than 112

the experim.t sh.d therefore be made by plunging the mixture into a waterbath

—This Solution may be cooled far below its congealing Point without Crystallization & then by a little agitation or the addition of a Crystal may be made to crystallize instantaneously almost, as you have already seen

It has no action with oxygen or Acids

Its action with Inflam: is the same with that of Sulphate of Potash except that the residuum instead of a Sulphuret of Potash is a Sulphuret of Soda

It is soluble in acetic acid producing a great degree of Cold during its Solution

Take of Sulphuric Acid diluted with an equal Quant of water 4 Parts - to this add 5 of the Powdered Sulph: of Soda - & 47 degrees of cold are generated

—By mixing Nitric Acid   Parts and of P. of Sulph: of Soda   Parts 58 degrees of cold are generated

5. Parts Muriatic Acid & 8. of this Salt produce 50 degrees - a sink of therm: from 50° to Zero

—Its decomposit. is an object of great Importance and a desideratum, at Present large Quantities of it are thrown away the cheapest ways of decomposing it yet known are those used in the

Decomposit: of Sulph. of Potash — It may be readily decomposed by the addition of Potash — It rarely exists pure in a native state

It has been found in the neighbourhood of Vesuvius in sea water and marine vegetables — It is immediately procured from the distillation of muriatic Acid

It is used in Medicine as a Purgative — Its taste is disagreeable but may be rendered less so by a proper addition of the acidulous Tart. of Potash

Combinations of Alkaline Salts with the Sulphurous Acid are called Sulphites

Sulphite of Potash — This may be obtained by exposing the Potash to the vapour of burning Sulphur or by mixture —

It is generally white and transparent, its Crystals of a rhomboidal figure resembling Rhomboidal Plates — Its taste penetrating and Sulphurous —

It effloresces in the air & changes to sulphurous Acid & becomes Sulphate of Potash from the oxygen of the air uniting with it and changing the Sulphurous into Sulphuric Acid —

It is decomposed by heat when brought to

a slight increase of temp. & decomposition, if to ignition - it emits dense vapours of Sulphurous Acid - & length a portion of Sulphur is separated, and the residue is a Sulphate of Potash

It is soluble in its own weight of water at 60° and the solubility is increased by heat

- The Sulphurous Acid combines so readily to the alkali that this Salt may be decomposed by the Sulphuric, Nitric, Phosphoric and Fluoric Acids

- Its nature is changed into Sulphuric Acid by absorption of oxygen if the nitrous & oxygenated muriatic acids be added

By mixing with it & Sulphuric Acid the Sulphurous Acid is separated and thus we have an easy mode of procuring the Sulphurous Acid

Obs. Production of this acid in its gaseous form is rapidly absorbed by water.

The Sulphite of Potash has been employed in Maine [illegible] manufacture of and contains a portion of Sulphuret of Potash in it. and it has been introduced as an external remedy into Medicine [illegible] some cutaneous affections

If Nitrous Acid be added – a precipitate of nitrous and flies off. as the Sulphurous Acid abstracts a portion of oxygen from the Nitrous acid by which it becomes nitrous – and the Sulphurous from this acquisition of oxygen becomes Sulphuric

The Sulphate of Soda is very analogous in properties to the Phenomena presented by the Sulphate of Potash

The Nitrate of Potash – This may be formed by a mixture of nitric Acid and Potash

During this mixture heat is generated – If nitrous Acid be employed a copious effusion of red fumes takes place – as a portion of Acid existing in the Alkali is here changed into nitric and by an addition of oxygen at the expense of the nitr. which thereby becomes exceedingly volatile from its loss of oxygen and flies off in red fumes – &c.

– This Salt consists of Prisms of six sides the ends are flat with two inclined to each other terminated by a wedge

This Salt is transparent and suffers no change from exposure to the Air – Its taste is peculiar cooling

100 Parts contain of Potash 51 3/10. of Nitric Acid 44 with 4 1/2 By heat approaching to Ignition the Salt is fused and if suffered to cool quietly into a crystalline mass

called Crystal Mineral (Sal Prunella)

If the heat be duly increased - the Acid is expelled not in the form of an Acid but in its constituent Parts of oxygen and Azot - and the Potash remains

One ounce of Nitre will yield 710 cubic Inches of the mixture of azote and oxygen Gas - about 29½ of the former to 70½ of the latter accord.g to Mr Davy

- This Gas is frequently used as a substitute (readily obtained) for the pure oxygen Gas

The alkali acts very strongly on the glass vessel or the crucible containing it to prevent which a mixture of portion of lime sh.d be mixed with the extract of Potash before the process is begun

This Salt is soluble in 4 times its weight of water at 60° and in an equal wt. of water at 212 It may therefore be easily crystallized

- Its Solution generates a considerable degree of Cold for which purpose it has been used in the Indies from time immemorial

With inflammable bodies when cold it has no action

It has no action with oxygen or Azot

With inflamm. bodies heated to combustion ignition it produces a lively Combustion

Hence has arisen a popular Error that Nitre
is a combustible body of a great activity —
but the Nitre itself is not an inflam: body it
merely causes other inflam: bodies to burn
with increased rapidity

Exp. Nitre brot to red heat in a Crucible
without inflammation — but most vivid inflam:
of several combustible bodies thrown into it as
Charcoal Sulphur common wood &c

This depends on a prodigious quantity of oxygen
which Nitre affords when thus heated

If Charcoal be the inflam: substance added
the residuum is found to be the basis alka
line part of Nitre united to Carbonic Acid
— If Sulphur be employed the residuum is found united to
the Sulphuric Acid — and this is the process
for forming a Salt called Sal Polychrest

Hence we may understand the use of the
addition of from 1/5 to 1/10 of Nitre in combus
tion of Sulphur to procure the Sulphuric Acid
viz to determine a Sulphur to burn with a
sufficient degree of brevity

Advantage is taken of this property of Nitre to
assist & sustain & fuse in producing certain

changes in bodies not easily effected by heat

It is also sometimes used as a test of the richness of a Soil — For the quantity of putrefied animal or any other Substance in a Soil and on w.ch its ameliorating richness depends is estimated from the quantity of fixt Combustible produced by burning it with equitable nitre

In all these Processes the nitre acts in consequence of the quantity of oxygen it affords

This was known to Mayow — he observed that inflamm.ble bodies wd not burn — without the presence of the air — but that even in cases they wd burn if mixed with nitre and hence concluded that the nitre afforded that principle in the air wch was necessary to Combustion — he therefore called this the nitro aerial principle

— Hence arises the rapid deflagration and detonations of certain Compounds of inflamm.ble bodies with nitre as Gunpowder Gunpowder

Effect of the Combustion of a Port fire under water so long as the Gas extricated move the water from coming into actual Contact

— The explosive of Gunpowder is owing to the instantaneous extrication of a number of elastic

fluids.

Effs. Combustⁿ of Arabic Gunpowder in wᶜʰ the gaseous fluids were collected.

This Label Composed of 18 Materials forming Gunpowder was probably known in some Eastern Countries where Nitre abounds much sooner than in England or in Prussia

It was known to Roger Bacon — and gave Knowledge with historic by Schwartz

Gunpowder consists of 75 Parts of Nitre — 15 of Charcoal and 10 of Sulphur.

The Ingredients must be Pure of the finest kind — and the Charcoal shᵈ be prepared from Willow Alder or Dogwood — not in ordinary way but

with Charcoal thus prepared the effects equal if only ⅔ⁱᵈ of the usual quantity of Nitre of Gunpowder made with common Charcoal, be employed

These ingredients are thoroughly triturated and mixed by a mallet and Pestle with a quantity of water — the mass is then dried

Water by steam is one very useful — by the heat of steam conveyed from some distance as in some Countries by the Sun

— This Water is then granulated by passing it thro a sieve of perforated Parchment and for some purposes it is cleared by agitation

See a paper of Mr Coleman in 2d Vol. Volume of philosophical Transactions

The fluids when sudden crystallization causes the explosion are Carbonic Acid Sulphurous Acid aeriform Gas — water of Crystallization converts into Vapour — Fourcroy adds a little Oxygenous Gas from decomposition of the water

The force occasioned by the explosion of 8 Grains of Gunpowder was according to C. Rumford sufficient to raise a weight of 1081 Pounds 1 to the pressure of 10,977 Atmospheres.

After deflagration of Gunpowder a residue remains equal to $\frac{1}{153}$ consisting of a little Sulphate of Potash — Sulphuret of Potash — and Potash united to Carbonic Acid

ct - Some of the Theories we have adopted with explain-
satisfactorily - here is no condensation of oxygen
and oxygen is already in a condensed state -
we have the Theory of Lavoisier and the cause
of heat and light - Caloric instead of being given
out on its imagine must be absorbed from
the air a great part of the oxygen of the Gas passes
from a solid to a gaseous form

Mr Crawford Theory - that heat and Light
depend on the diminution of Capacity is equally
applicable here for the Capacity of every Sub
stance is increased - the Carbon by becoming
Carbonic Gas and Sulphur by changing into Sul
phurous Acid - and water into Vapour - and the
alkali by being combined with Carbonic instead
of Nitric Acid

Mr Dalton imagined that the Principle of In
flammability was disengaged and caused the ap
pearance of heat & light - but this Theory is
unsupported by facts & experiments

- According to Mr heat and light depend on
the Pressure produced by the sudden disengagement
of the latent fluids but this also remains
to be proved

Another astonishing Compound Detonating Powder is the Pulvis Fulminans consisting of 3 Parts of Nitrate of Potash 2 of Carbonate of Potash — Soda and one of Sulphur — It must be as dry as possible to have a full effect and we must manage it so that the whole may be nearly melted before it is brought into any violent so as to explode — This is also caused by the sudden extrication of elastic fluids — — of the Acid bodies there is only one that can decompose or produce an Ammoniacal Nitrate with Potash. This is the Sulphuric Acid which having a stronger attraction for Potash — than the Potash has for the Nitric Acid unites with the Potash which the Nitric Acid is expelled — and this is the mode in which Nitric Acid is procured — To procure this Acid I mix in a Retort 2 Ounces of pure Nitre and — of the Sulphuric Acid — The Pharm: L. orders 2½ ounces of Acid to 6 of Nitre — and the Pharm Edin: half a lb.[s] of the Nitre — it uses about 30 of Acid & 8 of Nitre — The reason why I employ a larger proportion of Acid is that the whole of the Nitric Acid may be disengaged as

entirely and that the Sulphate of Potash in the
Mixt may be left with an excess of Acid

Eff. Three ingred.ts mixed in a retort by pour-
ing of Acid thro a short funnel — a tubulated
recipient ground to & mark'd retort was
then adjusted — — If d Recipient be not ground
it must be luted with a mixture of 4 p.ts
Sand and 1 P.t Clay — If d Recipient has
no Tubulature d Receiver must not be luted
too tight — — If d Sulphuric Acid that is em-
ployd have any inflam.ble substance mixed w.th
it it will tinge the color — it will abstract oxygen
from d Nitric Acid & Nitrous Vapours will
fill d Rec.r — The Operation with this quan-
tity shd be conducted in a Sand bath of about
one inch thickness and d Process will be finish'd
in about six hours — d.o Acid obtained about 3xvii
Drams & a half — but towards d end of the
process it is not Nitric but Nitrous Acid of a
Deep red Color that comes over — the heat requisit
being so intense as partially to decompose
the Acid and a considerable quantity of oxygen
gas [illegible] is extricated — generally about 10
Quarts — the last six of which are very pure

and should be collected by a bent tube ~~&~~ inserted into the tubulature of the receiver —

— If it is required, the portion of the oxygen Gas may be increased by augmenting the Temp.

— To procure the Nitric Acid Vapours for disarming contagious Effluvia of their virulence — a mixture of equal parts of Nitre and the Sulphuric Acid are placed in a ~~pot~~ Saucer inserted in a pot of heated Sand — these vapours give a misty appearance to the Air from their condensat. & mixture with the moisture of the Air — they destroy the foetid smell and arrest the progress of the contagion, probably by uniting with them in the same manner as the nitric acid unites with and destroys the ~~the~~ texture of — animal substances. —

— The decomposition may also be affected by substances containing the Sulphuric Acid as Alum — Sulphate of Iron but the Acid is impure and the produce small

— What remains after the distillation of the Nitric Acid is an acidulous Sulphate of Potash

Yet notwithstanding that in this Process the sulphuric Acid evidently seems to have a stronger

the nitric acid has – It is found that if to a quantity of sulphate of Potash & Nitric acid be added – a part of the Sulphat of Potash is decomposed and Nitrate of Potash is formed – This apparent Paradox was explained by Bergmen thus

He found that the quantity of the Sulphate of Potash thus decomposed was never more than 1/3 of the whole – and that of remaining 2/3ds one mounts into acidulous Sulphate of Potash – & no addition of nitric acid will decompose –

Here then are two Divellent Attractions and one Quiescent The quiescent attraction is that subsisting between the Sulphuric Acid and the Potash – The Divellent attraction are between the 2/3 of the Sulphate of Potash and the remaining one 3d of Sulphuric Acid so as to form acidulous sulphate of Potash – the other Divellent Attraction is between the Potash and the Nitric acid added – and the Sum of the two Divellent attractions being greater than the quiescent attraction 1/3 of the Salt is decomposed from its alkali uniting with the Nitric Acid

and the ~~other alkali~~ acid uniting to the remaining 2/3rds of Sulphate of Potash — But the Nitric acid will not decompose it and retains Sulphate of Potash — because it's attractions are there in their greatest force

Berthollet has given a very different view of the Subject — He says that in decompositions of this Sort and in all decompositions by the addition of a third body — two attractions are called into action — one is the real Chemical attraction between the bodies — the other is the attraction depending on the quantities of the bodies — and he contends that a body by its quantity may compensate for its want of chemical attraction

The facts adduced in support of this Theory are — that when any acid and alkali are in combination if we wish to decompose them by an acid of greater attraction for the alkali — a larger portion of this acid must be added than is previously have been required to saturate the alkali in its uncombined State — another argument of nearly the same import is that if to an acid and alkali already

in Combination a Quantity of acid be added of water Mineral fix'd Alkali than of acid wch w^d it is already combined yet that it will produce a partial decomposition.

The Alkali may be obtained from d Nitre by subjecting it to heat, but the Potash then acts very strongly on d Vessels — Therefore it may be mixed with ½ of Charcoal and deflagrated in a red hot Crucible in which case the Carbonate of Potash is formed in d Crucible and Potash in d Nitre is obtained it is comonly employ'd

Use:

It is doubted whether Nitre were known to d Ancients. d Nitre of d sacred writings was certainly Soda and Pliny at one time describes d Soda in another place he has been thought to describe this Salt of Nitre

It is found in great abundance in d Soil of Eastern Countries It exists in the Plants as d Tobacco d Sunflower and the Borage and if the Stalk of them be dried they will burn like a Sulphur match It is found in Calcareous Stones lying near and surface thus the Duc de la Rochefoucault found it in the

in the Chalk of Roche Guyon in the proportion of ʒj in the Pound — In calcareous Caverns in France and Germany It exists crystallized in a Cavern at Pulo near Molfetta

In Spain South America East Indies China N America &c It crystallizes at the surface of the soil appearing like hoar Frost and such soils are totally barren

To procure the Nitre from the Soil in South America — Cavities are dug in the outer grounds and made water tight into wch a quantity of Soil is thrown and a due proportion of water — when the earth subsides the water is pumped up and evaporated till it forms the rough Nitre in wch state we have it

Efflorescences of Nitre are often seen on the walls of old Buildings in damp shady situations on Privies Pigeon houses Stables Cellars & glittering on the surface of dunghills in dry weather Lime is also found united to the same acid

Hence arose the Opinion that the Combustion of animal and vegetable substances were accompanied with the extricating of a somewhat wch uniting with the air formed nitre and this opinion

is certainly well founded — On the Principle manufactories of Salts have been established particularly in France where from the great Consumption during the war & the difficulty of procuring it from the Indies rendered more frequently it an Object of great importance

For this purpose a Mixture of Soil with the ashes of Celery Stalks Privits & raking of the streets and some very Stable manure is placed where it is not much exposed to wind or light but where the air may be often renewed it is moistened and frequently stirred — the heat of the mass should be from 80 to 90. — The quantity of Nitre formed is ascertained by pouring water on a certain quantity of the mass so operated. Wood ashes are also added to change the Nitrate of Lime into a Nitrate of Pot Ash —

When the process is finished the Salt is impure containing an admixture of muriate of Pot Ash and as it loses by every Evaporation some of the Salt flying off with the Vapour. The mode of purifying it used in France was by the affusion of very cold water which dissolved the Nitrate of Pot Ash but not the Nitrate of Pot Ash

Mayow maintaind and ~~[illegible]~~ Thouvenel proved proved that the Acid was ye only part produced, ye Alkali & lime being present — and that the Acid was formed of something from ye putrescent mass uniting with a Part of the Air and this too before ye Composition of Nitric Acid was known

There was an experimt of Mr Chaptal which will discover repeating. ℔xxv of Chalk well washed was exposed in a close apartment to ye vapour proceeding from ℔x of Blood for eleven months from which were procured ℔iij of Nitrate of Lime and ℥j of ye Nitrate of Potash — whence proceed the alkali that entered into ye formation of ye Nitrate of Potash.

We now know ye Composition of the Nitric Acid and that animal & vegetable substances supply azote during Putrefaction — and the Alkali and Lime in ye mass favors the union of the azot & oxygen by wt is called disposing Attraction

Kirwan conjectured that in deep calcareous caverns the azot might be supplied from ye Atmosphere but it may possibly proceed from some animal matter adhering to ye Calcareous earth & Nitre is not a mineral production nor is

ure is the acid a mineral acid

Nitre is employed in Medicine as a diuretic Refrigerant and Aperient — It has been proposed for the purpose of supplying oxygen to the System but its effects in this way is questionable —

It is employed in Pharmacy for procuring the Nitric acid and in the Acetic Water and of Aqua fortis — It is used in Dimestic way has an antiseptic and imparts to Meat a fine red Color — It is used in the formation of Gun powder and of imbrueing of Sulphur for Sulphuric acid It is used also to procure an intense temp. such as is required for melting of Platinum which is done by throwing in a handful of nitre into the fire

Nitrate of Soda — Rhombic Nitre — It has a bitter slightly deliquescent taste

It contains 40. Parts 52 acid & 8. Water

It decrepitates by an increase of temp. & if the heat be duly increased it is expelled & the Base left behind

It is soluble in about 3 times its weight of water at 60° and in almost less than a boiling temp. Its chemical qualities with regard to other bodies

are the same as those of the nitrate of Potash
— when decomposed by a heat sufficient to drive
off the acid of saltpetre is soda strongly
disposed to act on the vessel
It may be decomposed by Potash and by the
Sulphuric acid
It is found artificially as it has been
said to exist naturally in Spain —
It is used for no purpose whatever in
medicine or the Arts
— Exhibition of the Nitric acid after the
Bowels begun at the last Lecture
The manner in this distillation shd be kept very
cool — by wrapping a linen cloth round it on
which water is made to drop from a basin above
by inserting into the beak of the Syphons of worsted
or ~~woollen~~ woollen thread,
This Acid has been called the Spt. Nitri fumans
or Glauber's Spirit of Nitre — Its Sp. Grav.
is 1500 —
In this state it is not pure nitric acid much
of its oxygen having been dissipated towards the
end of the distillation by the requisite heat
— To obtain it tolerably pure — 1/3 of the

whole product shd be drawn off with a very gentle heat below ebullition — the 2/3ds remaining in ye Retort will be tolerably pure — Mr Lowitz however it is generally contaminated with a small portion of muriate & of Sulphuric Acid — to free it from these it may be mixed with a small portion of ye Nitrate of Silver and redistilled to dryness

Nitrite of Potash — This is not obtained by mixing nitrous acid & Potash for a part of ye nitrous is converted into nitric acid forming Nitrate of Potash and ye rest of ye nitrous acid must be evaporated from it in deep pans

It is procured by expelling from Nitrate of Potash a Part of its oxygen by heat

This Nitrite of Potash has generally some slight alkaline Qualities It is very soluble in water

When mixed with nitric and ye Nitrous acid is expelled in deep Vessels and pans, &c.

Nitrite of Soda is little known

Muriate of Potash called also Sal Digestivus Sylvii — forms cubic Crystals taste strongly saline

100 Parts Contain of Acid 36 Alkali 64 The

Salt being dried by a Temp of 80° or according to Bergman 61 of Alkali 31 of acid & 8 of water

It decrepitates on an increase of Temp & at length melts & evaporates without change

It is dissolved by 3 times its w^{t} of water at 60° & nearly the same proportion of boiling water

It is crystallizable by the usual mode of slow evaporation

It has no action with Oxygen Acid or Inflammables

It may be decomposed by Sulphuric or Vitriolic acids — but the separation of the Alkali is a difficult process & might reward any one who could discover an easy way of doing it.

It exists in Sea water Salt Springs the ashes of vegetables and in urine

It is procured chiefly by artificial Combination

It is of no Esteem in Med: or the Arts

It was named by Bergman Alk. veg: Salitum

Muriate of Soda is a salt peculiar interest^{g}

Its appearance is different according to the mode of its pp^{tion} — commonly cubical but sometimes in hollow quadrangular Pyramids

Its taste is agreeable and purely saline

It consists of Soda 53 parts Mur Acid 38 3/10 water of combination not of Crystallization 8 2/10 —

It decrepitates on an increase of Temperat. at a higher temp it melts suffering no chemical Change — but if that of being more compact when it has grown cool — but by an increase of the Temp to a due pitch a part of its muriatic Acid may be expelled

It attracts humidity from a very moist air but its deliquescence depends on contamination

It is the Salt most commonly employed to produce cold by mixing it with snow particularly in ice houses — and the cold thus produced is equal to —4.

It requires 3 times its weight of hot water at 60°. and nearly the same at 212 to dissolve it hence it cannot be crystallized in the usual way It must be done by slow evaporation.

When evap. beyond the Point of Saturat. Particles of a cubical form are separated and first appear in the Surface — ~~one~~ one of them by its gravity forms a slight correspond. depression in the surface. Other particles separated in the same way attach themselves round it, ~~to it while~~ while it continues sinking by its specific gravity

a Pyramid is formed with its apex downwards some times of an inch in length

It has no action with oxygen or the Inflammables. It may be decomposed by the Sulphuric & the Nitric acids — and by the Potash

When decomposed by the Sulphuric Acid it it causes an Effervescence and a disengagement of muriatic Acid Gas and this is on many occasions the most convenient mode of obtaining the muriatic Acid Gas for this purpose the muriate of ~~Potash~~ Soda shd be very dry and pure —

This acid Gas has been proposed and tried by Morveau and found useful in checking the progress of Contagion in the same way as the nitric Acid employed by Dr C Smith

— To procure the Muriatic Acid — we must employ the Sulphuric acid diluted — In the Ph. Ed. lbij of salt are mixed with lbj of Sulphuric acid previously diluted with lbj of water, In the Ph. Lond. the Proportions are lbx of the salt with lbxij of the Acid previously diluted with lbx of water — the proportions I employ are ℥xv of the muriate of Soda to ℥viij of Sulphuric Acid

previously diluted with ℥j of water

— The Reason why I employ a larger proportion of acid is that the whole of ye muriatic acid may be disengaged, — a very gentle heat is applied and (else the acid will rise in the form of Gas) and it is gradually increased — Thus ℥x of the muriatic acid is obtained of ye Sp Grav: 1190 and the whole of the acid is disengaged — but it is objected that there is some danger of ye Sulphuric acid arising with ye muriatic — This does not happen if ye heat be sufficiently moderate —

It is also objected that the residuum is acid but this may be obviated by adding to it a quantity of Chalk

According to ye remarks of Dr Percival if ye acid that comes over be divided into three parts the first and last portion are the strongest

— It is true that a considerable portion of the acid is expelled in ye form of Gas and wholly lost — but this loss may be prevented by adjusting to ye retort a series of Woulfe's Bottles — in wh the acid Gas being so rapidly absorbed by water cannot possibly escape — and Kirwan has experted that muriatic acid may be thus procured.

of the Specific gravity of 1800. – Care however must be taken to keep these Vessels or Receivers cool – else the water in them will rise to 212°

– A mode of decomposing the Muriate of Soda by a cheap & easy process is a great desideratum in Chemistry and the alkali of wh it consists is an article of value

During its distillation much larger quantities of the Sulphate of Soda are formed than are consumed in medicine – and this is not easily decomposed tho with less difficulty than the Muriate of Potash – Hence Muriate of Soda has sometimes been decomposed by ~~mixing~~ the Muriat Sulphate of Iron or green Vitriol – and also by the acetite of Lead, a double elective Attraction taking place in both cases, the nature of the last decomposition I shall explain hereafter – It was first proposed by Scheele

L. Dundonald's patent mode consists I believe in mixing this salt with clay wh detains a part of the Soda while the Acid is expelled by an ~~mon~~ elevated Temperature

Vid Annals de Chemie Vol XIX

Muriate of Soda is employed in Medicine as
a remedy for worms and for Evacuation
in a Clyster by Dr Rush of Philadelphia
It is largely used in a domestic way
is a pleasing stimulant and a pure digestive
Wild animals have a great avidity for it
and in Germany and America, it is used as
a Bait to ensnare them being mixed with
other articles on which they usually subsist
It is employed in an antiseptic for preserving
flesh but Dr Pringle found that if it too
little Salt be used Putrefaction is promoted
It is used also in the glazing of earthenware
and in preparing the new bleaching ma
terials
It abounds as a mineral production in England
Russia Persia Poland Germany Spain
East Indies Asia and America, at Cadiz
in the Province of Catalonia in Spain there is
a mountain of Salt 4 or 500 feet high
Large Collections of it exist in mountainous
mines in Spain Algiers Tunis in the whole
Island Ormos in the Persian Gulph is composed
of it

A considerable quantity is found in Cheshire

It is of different hues viz. red, white, yellow purple white according to the nature of the foreign substance with which it is contaminated its common name is Rock Salt when stone coarse and colorless it is called Sal Gemmæ

Its Sp. Gravity is 2143 to water 1000

Its Crystals are cubes or parallelopipedons

The mines in Wielicka in Poland are very wonderful having been worked for 600 years and many dwellings Chapels a Mineral Lake &c are excavated within them — This subterraneous town is said to be illuminated to present a most splendid beautiful brilliant appearance viz. I can readily believe from what I have seen in Cheshire

— Two Opinions have been entertained respecting the origin of these consolidated strata of Salt, some suppose them to have been deposited by the waters of the Ocean — viz. evaporating & exsp. the Salt is the form of Crystals — others believe with more truth that the Salt has been found by itself but of this I shall speak more fully hereafter

It is found in Salt Springs Lakes &c but most abundantly in ye Ocean — there are springs saturated with it in Cheshire — Lancashire & Norfolk — In ye Ocean ye proportion of Salt is according to Kirwan from 1/25 to 1/30 — or 4 p^r Cent. others have computed it from 1/30 to 1/50 — this is really the same with rock Salt but differing in Purity

From Salt Lakes overflown plains &c it is obtained by spontaneous Evaporat. and called Bay Salt — on ye Coast of Spain Portugal & especially France water tight ponds are made for this purpose — Salt is obtained in a similar way in ye provinces of Russia especially Crim Tartary in Africa & East Indies &c — It is seldom white being mixed with earthy matters and generally in large sized cubical Crystals —

Salt is frequently found to contain some Muriate & Sulphate of Magnesia — rendering it deliquescent unsavoury and delique septic —

In Britain artificial Evaporation is employed & this is called boiled Salt.

When Sea water containing Sulphate of Magnesia and Muriate of Soda are cooled below 32. a double elective Attraction takes place forming Muriate of

Magnesia and Sulphat of Soda. If however the Temperature is again increased a former process of separation will not attend

To obtain the Salts pure it should be procured by very slow evaporation as in case with regard to the Sundery Salts — or by repeated evaporation in the Dutch called Salt upon Salt

Dr Dundonald's Contrivance was to fill with Salt a conical vessel perforated at the bottom a hole and open at the apex — But on twenty lbs of Salt in as much water as will dissolve saturate this is found boiling but on the rest of the Salt in the Vessel and will do before no more of the muriate of Soda but passes off charged with a considerable portion of the volatile salts at the perforation in the base of the Cone — The remaining Salt however is not perfectly pure

Quere whether was to take an exact quantity of the water containing Sea Salt and throw in a portion of Sulphate of Soda — a Quere about which might by decisive Experiments easily be taken to obtain the volatile Salts

Combinations between the oxygenated Muriatic Acid and Potash — The best

mode of procuring the oxygenated or rather the superoxygenated Muriate of Potash is to cause the oxygenated mur: Acid to pass thro' a Solution of Potash

Exp. exhibiting a Retorte with a series of Woulfe's Bottles adjusted, the two first of wch contained water the third a Lixivium Caust of the Ed Pharm: — In the Retort was a mixture of ℥xij of the muriatic acid with ℥iv of Manganese which being then distilled with a gentle heat — the oxygenated muriatic acid Gas is absorbed by the water in the first and 2d Receiver constituting oxygenated muriatic Acid and its ~~is absorbed~~ what of the Gas goes over into the third receiver, is absorbed by the alkaline Solution — forming partly the hyperoxygenated muriate of Potash — a fourth receiver may be added to collect there any remaining Gas which may escape the three first receivers

— The Crystals of oxygenated muriatic ~~acid~~ of Potash are Lamellar or Plates of 4 or 6. sides — These are transparent & colourless — of a sharp saline taste impressing the tongue with a sense of Coolness — and suffering no change from exposure to the Air

If Muriat Salt be exposed to an intense & temperd
heat it first undergoes a aqueous fusion and then
the true fusion but is found to have been converted
into a new muriate of Potash and if a pneumatic
apparatus oxygen Gas is collected in greater purity
than by any other means

100 grains of Supercarbonated Muriate of
of Potash will yield 100 cubic Inches of the Gas of
wch only 3 Per cent is carbonic Gas — and it
loses its oxygene at a much lower Temperature
than the Nitrate of Potash

It dissolves in 17 times its wt of cold and 2½
times its wt of boiling water

This Solution does not destroy colour — it may
be evaporated so as to form Crystals either by the
artificial or spontaneous evaporation

It has no action with acid of oxygen

It has a very remarkable action with inflam-
mable bodies for a quantity of oxygen it can
furnish and the facility with which it parts from it,
for this purpose an intense heat is requisite
and it is then found to deflagrate & detonate with
inflammable bodies more than the Nitrate of
Potash or Saltpetre

If you mix them ingredients separately will together the deflagration is more rapid

Eff. showing that and the Temp being elevated a very little by placing a mixture of Sulphur underoxygenated muriate of Potash on a tin plate held over a gentle fire

This effect may be excited in a pleasing manner by friction or Percussion

Eff – Rubbing in a mortar a p. of Sulphur & hyperoxygenated Muriate of potash previously mixed occasioning an immense number of small explosions

Eff. of percussion with instant detonation

Ex. These experiments a mixture has been said to consist of 6 Parts hyperoxygenated M of Potash – 1 Sulphur & 1 charcoal –

A similar deflagration takes place when the hyperoxygenated M of Potash is mixed with Sugar Indigo Spunk Oil Cotton Wool &c

If mixed with Phosphorus in d Proportion of 5 of d & h. oxy. Mur. of Potash with 1 of Phosphorus Friction will produce a very smart explosion with flame – Sulphur Direct only 1/2 grain of each

This property of deflagrating on Friction or Percussion is not peculiar to mixtures of ye h. oxygenated muriate of Potash with inflammable substances it also takes place tho' to a less extent when mixtures of inflam. Substances with Nitrate of Potash are subjected to similar Friction or percussion —

In these experiments that the minute particles are brought into closer contact so as to favor Chem. action.

An Attempt was made to substitute this Salt for Nitre in ye manufacture of Gunpowder at Essonne in ye Year 1788. but the trituration employed kindled the mass killed one of the Chemists and wounded several others —

A similar trial was made with great Care at Woolwich & it was found that when the mouth or Caliber of a piece is small Powder made of this Salt will carry ye ball much farther than with ye common Gunpowder but ye reverse happens when the mouth of ye Piece is large.

These Circumstances with ye danger in manufacture and ye dearness of ye h. oxyg. Mur. of Potash will prevent its coming into general use for this purpose.

a very slight increase of Temp. is sufficient
to kindle a mixture of this Sort — Thus a por-
tion of such a composition exploded very nicely
probably from having been placed by Mr Godfrey
of London on his own Chimney piece

This Salt parts from its acid much more
readily than do common Muriate of Potash —
If a large Quantity of Sulphuric Acid be poured
upon it a violent explosion and disengagement
of elastic fluids takes place — This may be mode-
rated by pouring over it very much Potash —
a saturated solution of Acid & then introducing Acid

Exp. — a small Quantity of hyperoxygenated Muriate of Potash was
placed in a Glass Cupel — over it a solution of Acid, then
thro a capillary tube a minute portion of Sulphu-
ric acid was introduced upon the Salt — and the
oxygenated muriatic acid was disengaged (rendering the
fluid above of a yellow Color) and at the same time
a large Quantity of oxygen Gas

If the Salt be mixed with inflammable matter
and Sulphuric acid be added immediate inflamm
takes place

Exp. — a mixture of Sugar and hyperoxygenated muri-
ate of Potash — touched with a particle of Sulph. acid
such an inflammation is excited as may often be

of use to the Chemist for the purpose of lighting his Candle in the dark

If a larger proportion of these Substances be mixed a violent deflagration takes place —

Exp. exhibiting this — and a small like that of nitrous acid produced

The Effect is somewhat greater if ½ of Sugar & ½ of Charcoal be mixed with & Salt & deflagrated in the same manner

This was accurately seen by Dr Higgins of London but it equally evinces that he did not know what it was — Berthollet discovered its nature in 1786 — The mode in which he found it was that already noticed — The alkaline Solution ought not to be stronger than the Lavoisian Caustique in which Pl 2d — for if it be too strong the common Muriate of Potash is formed & oxygen gas disengaged

The quantity of hyper oxygenated muriate of Potash obtained is small — for when the product comes to be examined three diff.t Salts are found in it — 1 common Muriate of Potash formed largest Quantity 2 oxygenated muriate of Potash slightly combined in with the acid

wch she retains its yellow Color and its property of discharging the Colors of other Substances 3d Super oxygenated Muriate of Potash called also Super oxygenated Muriate of Potash — The reason why it is so called and the Cause of the formation of so large a quantity of common Muriate of Potash is thus — The Portion of Acid wch unites with the Potash to form Super oxygenated Potash has 6 times more oxygen combined with it than it is combined with it in its ordinary state — and this surplus of oxygen it gains at the expence of the rest — so that only one sixth of the whole quantity of oxygenated muriatic Acid can enter into combination with the Potash so as to form the Super oxygenated Muriate of Potash — and of these five parts being deprived of their additional dose of oxygen enter into combination in the state of ordinary muriatic Acid and form Muriate of Potash

In other words it may be explained thus — "The oxygenated muriatic Acid does not combine with the Potash, in the state it is in it reaches it, on the contrary it divides into two Parts one of wch gives up its oxygen to the other — so forming Super oxygenated muriatic Acid & common

muriatic acid — in sd St. combining with sd Potash they form Hyperoxygenated muriate of Potash — and common muriate of Potash.

Somewhat analogous to this was seen to take place when Nitrous ~~[illegible]~~ Acid is mixed with Potash — a Part of sd Nitrous Acid — becoming nitric (by depriving sd other portion of its oxygen) — unites with sd Potash forming Nitrate of Potash — while the Portion so deprived of its oxygen, escapes in deep blood red fumes

— From these experiments we learn that the Muriatic acid may exist in three different ways or according to modern chemists in 3 different state of Combination with oxygen — 1st in sd State of ordinary Muriatic Acid — 2. oxygenated muriat. acid — 3 Hyperoxygenated Muriatic acid

— Mr. Berthollet soon after this discovery attempted to procure this Hyperoxygenated Muriatic acid pure & ~~[illegible]~~ uncombined ~~state~~ with alkali but in vain — for in decomposing sd Hyp: ox: Mur of Potash the Hyperoxy. mur Acid ~~because~~ also decomposed resolving itself into oxygen Gas and oxygenated muriatic acid and this extrication of oxygen Gas is the Cause of the inflammation you have witnessed

The only use to which the oxygenated muriate of Potash is applied is for the Cure of Cancerous diseases in doses from iij to iv grains three times a day gradually increased to xij or xx grains three times a day — In large doses it occasions most violently severe heart burn — Its efficacy like that of the Acids is supposed to depend on the oxygen it contains — for it has been proposed to secure its decomposition in the System by exhibiting at the same time a certain very weak mixture of Nitric acid —

It has been employed also externally in the Cure of cancerous ulcers and is said to affect the mouth in the same manner with Mercury

It was at first called the oxygenated Muriate of Potash but now very properly the Hyperoxygenated Muriat of Potash

A similar Combination may be formed with Soda of which the Phenomena are nearly the same as above described excepting that it is deliquescent in the air

In this Place I shall briefly defend the Condensation of the Power of oxygenated muriatic Acid in

Destroying Colours both animal & vegetable viz
is so great that only one or two experiments wch
have been lately discovered can resist it

This property was discovered by Scheele from
its having destroyed the colour of the Cork and of
the green web of a bottle in wch it was infused

Experiments shewing the immediate destruc-
tion of the colours of — in infusion of Cudbear viz
with ordinary Ink — Indigo wch is already
deposed in Sulphuric Acid and Cochineal
wch is an animal substance

Some chemical Processes are adopted by Dyers
to fix colours so that they may resist the influence
of light Air &c but these fixed colours such as
the Turkey red or Indigo blue cannot resist
the action of this Acid

Exp. with the various shades of printed Cottons
of various colours & textures — wch lost their colours
in an hour completely but colours fixed with
the Acid of a mineral Acid called the Oxygenated
Acid must be the action of the oxygenous Acid

This oxygenous Acid has the property of
bleaching & yellowish brown of the vegetable fibre
with wonderfully quick rapidity and quite as complete

as by the tedious process of bleaching in the ordinary way — being completed in 1/16th or perhaps as is be required in 1/12 of the time — besides that it can be carried on independent of weather and at all seasons precluding at the same time the necessity of bleachfields

To procure the oxygen and for this purpose instead of distilling first the Muriatic Acid & then redistilling a mixture of this with oxyd of manganese, 16 Parts of Sea Salt, 6 of the oxyd of Manganese and 12 of Sulphuric Acid diluted with an equal Quantity of water are employed — after the Operation of Distillation the residuum is Sulphate of Soda and this is the Salt wch I mentioned as being formed in such Quantities from the manufacture of materials used in bleaching and ~~[illegible]~~ the decomposition of wch is an object of so much importance

This Acid is sometimes applied in its gaseous form but in that Case the goods must be kept constantly moist or they are infallibly corroded

The oxygenated muriatic acid Gas is not condensed by water but in a solution of 1/50 or 1/100 Part of Potash or Lime forming an oxymuriate

of Potash & Lime wh. is less corrosive - besides that the workmen employed are less incommoded by the fumes - and this oxymuriate of lime or Potash destroys only the vegetable colors and not dyed colors - ~~besides~~ nor does it destroy a foolish addition to our muslins of a piece of Cobalt & Lead in imitation of the India muslins

Thus in bleaching this acid in consequence of the oxygen it contains & which it readily parts with answers the same purposes as exposure of the Substances to be bleached to the action of Light Air &c and when it has been used for this purpose losing the surplus of oxygen it becomes com. muriatic acid -

It has been used too for banishing color from substances used in the manufacture of Paper and of Ink from Paper to be remanufactured but not to bleach animal matters as wool Silk &c.

Ammoniacal Salts as they have been called or combinations of the Ammonia with the Sulphuric Nitrous and muriatic acids fall next to be considered — These combine with the usual

Phenomena increase of Temperature &c

They are all different from the compound Salts just described but less so than the constituent Parts of which they are composed — and on the addition of a fixed alkaline Salt they are decomposed emitting a strong smell of volatile alkali

Sulphate of Ammonia called in the French nomenclature Sulphate of Ammoniac consists of crystals which are flatted prisms of six sides terminated by pyramids of the same number of sides sometimes in the form of Laminæ or needles

Its Taste is bitter and pungent

100 Parts contain according to Kirwan 24.14 of alkali 54.66 of Acid & 21.01 of water

On increase of Temp: it decrepitates & fuses & is at length dissipated leaving no residuum in the Retort   if conducted in a retort to which a receiver & pneumatic apparatus are adapted a liquid ammonia is obtained in the receiver and in the pneumatic apparatus a mixture of Sulphureous acid & azotic Gas

and at length if the process be continued a Sulphat of Ammonia is found in ye receiver with an excess of acid — & but a fourth part of the ammonia disappears — and it continues to disappear on every repetition of the process

Here the Hydrogen of ye Ammon unites with the oxygen of ye Acid forming water — a part of the acid losing its oxygen becomes sulphurous Acid — and ye azot of ye ammon is set at liberty

This Salt dissolves in twice its weight of cold water and an equal weight of boiling & may be easily recovered in ye form of crystals

It has no particular action with oxygen gas or azote

It is not decomposed by inflam. bodies as Charcoal as the Salt undergoes a chemical change at a lower temp than wd be necessary for ye Charcoal to act upon it

— No acid having so strong an attraction for Ammon as Sulphuric Acid — of course no other can disengage it — but a partial disengagement may be effected by Nitric Muriatic Acid on ye principles before explained

with Nitrate of Potash it deflagrates as ~~a~~ an inflammable matter wd do & this may illustrate the power of ye Nitrate of Potash in detecting inflammable matter in any substance wd is ye present existed as you know in ye Sulphate of Ammonia or more properly ye Ammoniac

Exp

It is decomposed by ye fixed alkalies and a pungent odour disengaged — a ready test is thus furnished for detecting the presence of Ammonia for if the ammonia thus escapd in ye form of fumes be brought into contact with ye fumes of muriatic Acid and they unites they unite and form a very evident white Cloud of Fumes Exp. —

And by reversing the experiment we have a ready test of ye presence of muriatic Acid —

It can scarcely be called a native production It has been said to be found in ye neighbourhood of volcanoes & in some lakes of Tuscany

It is synthetically formed in ye Soot of [illegible] Pit coal from a union of Ammonia & Sulph. Acid

It is applied to no use

The Sulphureous Acid unites with Ammonia & applied in a form of Gas forming a Sulphite of Ammonia wch is a crystallizable Salt but not at all interesting

Nitrate of Ammonia when crystallized is in the shape of prismatic needles. Its taste is sharp and Saline in pressing the tongue with a sense of cooling

100 Parts of containing most water of Crystallization consist of 23 of Ammonia according to Kirwan 37 of Acid & 20 of water But Mr Davy supposes that the Salt when dried consists of 19.8 Ammonia 74.4 Acid and 5.7 water

It is very volatile and fusible and volatilized Salts — when elevated to a heat of 230 and to Cause it to rise in Vapour — unchanged — but Mr Davy remarks that this varies considerably according to the Quantity of water of Crystallization when perfectly dry it sublimes in Vapour fuses at a temp between 275 & 300. at 320 it becomes fluid and is decomposed between 356 & 360 — If suddenly heated to a high Pitch as by projecting it on a red hot Plate a remarkable

change is produced and it deflagrates with violence

Experiment

This takes place without any addition of inflam matter as the Salt contains in itself the inflammable matter & the oxygen Gas wh. unites with it in the deflagration — and this deflagration takes place without the presence of air —

When this is ~~carried~~ conducted so as to collect the products a remarkable change is found to have taken place — for the Purpose take a tubulated retort of earthen ware — Connect with it a receiver and a tube to convey elastic fluids to a Pneumatic Apparatus — Heat the retort to redness & throw in a portion of Nitrate of Ammonia into it thro' the tubulature stop the tubulature immediately — throw in successive portions in the same way and on examining the result nothing will be found in the retort — weak nitrous acid in the receiver and in the Pneumatic apparatus large quant of azotic Gas — but the volatile alkali or ammonia has entirely disappeared and a great portion of the nitric acid, this we are now prepared to understand — The Nitric acid

Acid consist of oxygen and azot — and Ammoniac of hydrogen and azot — During the deflagration the oxygen of the Nitric Acid combining with the hydrogen of the ammoniac forms water and the azot of both these substances is set at liberty in the State of Gas — But as the Ammoniac in this Salt does not contain a sufficient quantity of hydrogen to combine with the whole of oxygen of the Nitric Acid so as to form water a part remains in the State of Nitrous Acid mixed with the water — in the manner

When Nitrate of Ammoniac is heated to a Temp.e of 450°. it begins to boil and Nitrous oxyd or oxyd of azote is disengaged — this must be distinguished from the Nitrous Gas consisting of the same constituent ingredients in very different Proportions — It is the Phlogisticated Nitrous Air of Dr. Priestley

If the Nitrate of Ammoniac be perfectly pure and heat steadily pursued between 450 & 500 it is principally converted into this Gas but a small portion of the Salt comes over

100 Grains of the Salt with produce about 85

cubic Inches of this Gas

For some account of its properties we are indebted to D. Priestley and to Berthollet but most of it to Mr Davy formerly of Bristol now of the Royal Institution of London

It is transparent & colourless - has a sweet pleasant taste & unpossible Odour - It is an elastic compressible fluid and its Specific Gravity to that of Air is as 1014 to 1000 One cubic Inch weighing about half a grain

Water absorbs of it about an equal bulk (which is separated by boiling) and on it absorbs of Nitrous oxyd it parts with Atmospherical Air

It consists according to Mr Davy of 63 parts of azot and 37 of oxygen in 100

We have now found three substances which on burning so as to form different Compositions by its different proportions

The air of the Atmosphere — Nitrous oxyd — Nitrous Gas — Nitric Acid — substances differing in qualities from each other in the highest degree but all formed of the same Ingredients

Atmospherical air contains 72 of azot & 27 of oxygen or 77 of azot & 22 of

Nitrous oxyd contains 37 cty. 63 acid

Nitrous Gas contains 56 cty 56 acid Gas. 32 cty. 68 cty. Davy

Nitric Acid ——— 70 cty 30 acid

By heat the Nitrous oxyd may be resolved into Nitric Acid and 2 Vols of Atmospheric

It differs from Nitrous Gas in not combining with oxygen when brought into Contact nor does it yield oxygen to

Nitrous Gas may be converted into this Gas by exposing it to substances abstracting a Part of its oxygen as the sulphuret of Potash metals Sulphites

It also differs from Nitrous Gas in being fit for maintaining Combustion — Lighted Candle burns with increased quantity of rose colored flame but if cast fairly kindled it is extinguished & the same if Phosphorus Charcoal —

Hence the erroneous idea that this Gas will maintain combustion of some substances best out of others

Not unfit for respiration — if an animal be introduced into it — the animal is at first

more active for a while then it grows much agitated & oppressed — breathes with difficulty is unconscious and dies

When restricted for a short time it produces the most wonderful effects — a fulness of the head tingling in the ears [illegible] in the breast an profound and a strange intoxication & exhilaration succeeds expressed in the most extravagant effusions of mirth & ridiculous gesticulations tho' not withstanding that the person is conscious of the ludicrous figure he exhibits he still finds it impossible to restrain

This is not followed by any languor or headache the effects are different in different persons & a longer continuance of the inspiration (from 1 to 10 minutes) is required in some than in others — By use it becomes more agreable and Mr. Davy concludes that the period is not remote when it will become a pregnant source of debauch & a superficial taste may be formed according to his calculations for two pence — The apostles Peter habits that is when at least disposition to the apoplexy is suspected & in Robinsons

Persons liable to Hysterica w.ch is the Case with all women its use may be less safe —

I firmly believe from I have witnessed of its Effects that the representations of Mr Davy are not exaggerated with regard to its Effects

It vanishes in a considerable degree in the lungs a smaller quantity being expired than is inspired and seems to enter into the mass of blood

It may be combined with pure alkalies

100 parts of dry Nitrate of Ammonia heated to between 250 & 500 degrees yields 22 of the Nitrate of Ammonia undecomposed 3 of Nitric Acid 32½ of water 42½ of this Gas

In this process the Hydrogen of ye [illegible] Ammonia combining with one part of ye Oxygen of ye Nitric Acid forms water — while the azot of the Ammonia set at liberty — combines with almost all ye remaining oxygen of ye Nitric Acid forming this Gas —

This Gas w.ch was first seen by Dr Priestley was named erroneously by him ye dephlogisticated Nitrous Gas as before mentioned — by the Dutch Chemists — Gaseous oxyd of Azote (oxyd denoting that it is not combined with oxygen sufficient to convert it into an acid) but as this name is equally

applicable to the nitrous Gas — the last has been called ye more oxygenated gaseous oxyd of azot. the former the less oxyg: gas: oxd of azot but these are long names & Mr Davy prefers that of nitrous oxyd. — retaining for ye more oxyg gas oxyd of azote the old name of nitrous Gas

This nitrous oxyd was supposed to be that Combination wh constituted contagious Effluvia but that Opinion is now going into eternal Oblivion

The Nitrate of Ammonia is deliquescent in the air in a slight degree it dissolves in an equal wt of ~~boiling~~ water at 60°. & in ½ its wt of boiling water

It produces during its liquefaction a greater degree of Cold than any other Salt sinking the mercury in ye Thermometer from [illegible] 50 to + 4

It may be recovered from its solution in ye form of Crystals by evaporation wh shd be very slowly & cautiously performed — Spontaneous Evaporation is the best — for the Temp requisite for ye complete expulsion of the watery fluid will volatilize the Salt

This Salt has no action with oxygen or azot

It deflagrates with inflammable bodies

Hence Ammon gave the name of Ammonia to this Salt from Ammonia a Country of Lybia where it was mostly procured & where Jupiter Ammon was worshipped - - - - - - - - - - - - - La Grand

mix them together and by percussion the effects is produced with a smart detonation

It is decomposed by Sulphuric Acid & fixed alkalis

It exists naturally in the Mother water of Nitre but is almost always obtained by direct Combination of the Acid & Alkali together

It is used sometimes for the production of Cold but principally for procuring the Nitrous oxyd

Muriate of Ammonia(a) is a valuable Salt both in Medicine and the Arts it may be obtained in Crystals wh. are generally Pyramids of six sides sometimes of a cubical shape

It is ~~generally~~ commonly of a different form being in cakes of a large size with an internal striated texture slightly flexible under the Pestle — It is not deliquescent in a dry Air Its taste is peculiarly sharp & pungent — In the sublimed form that is in the cakes commonly known 100 Parts contain 25 of Ammonia 42.75 of Acid & 35.25 of water

On increasing its temp almost to redness it sublimes & was always thought to be condensed unchanged but Baume says that a small part of it is decomposed — If confined it may be fused

It may be dissolved in 3½ times its wt. of water
at 60 and in an = weight of water at 212°.
producing if dry 32 degrees of cold in its Solution

It has no action with oxyde of Arsenic It is
decomposed by Sulphuric and by Nitric Acid
– If Nitric Acid be poured upon this Salt in a cold
little action is produced but if the temperature be
raised an effervescence takes place with a disen-
gagement of pungent caustic vapors resembling
the oxygenated Muriatic Acid and it is in fact
a nitro-muriatic Acid for on the affusion of the
Nitric Acid & application of heat a portion of the Muriatic
Acid is disengaged which uniting with a part of
the Nitric Acid forms vapors of Aqua Regia as it
has been called wch is extensively procured by this
process in some Manufactories

The Ammonia may be disengaged from the acid
by the addition of Potash or Soda – It is however more
readily done by Lime of wch hereafter

The muriate of Ammonia deflagrates with the
nitrate of Potash in the same way as the Sulphat
of Potash – and there arises a very pungent vapor
of Nitric Acid Muriatic Acid & Nitrous Gas & watery
vapor muriate of Potash being left in the retort

It is found in the neighbourhood of Volcanoes in China in crevices of different Colors as grey red green &c from the emanations with it is mixed it is also found in Solution in some Lakes of Tuscany in the Counties of Pisa &c in Sicily it must be considered as a volcanic production

It is chiefly imported from Egypt where it is procured by burning from the soot of animal excrements — which is placed in Glass Bottles about ⅓ a Yard in diameter terminating in a short neck and a bellow — these bottles are exposed to a strong heat & Sal Ammoniac rises to the top of the Bellows where it adheres & assumes the form of a concave Hemisphere — In the combustion of Animal a Sulphate of Ammonia is formed — and by steeping the soot in water and distilling from lime, a weak Ammonia is collected — then to this is added Sulphuric Acid — forming Sulphate of Ammonia with is again decomposed by a double elective Attraction by the addition of common Salt forming Muriate of Ammonia & Sulphate of Soda & this is one fertile source of the Glauber Salts used in the Shops — it might be decomposed into the Muriatic Acid but this is very costly

It is also obtained more especially is prepared by distilling urine and mixing it Product with the mother water of Salt which contains muriate of Lime & Muriat of magnesia

It is used in medicine as a diaphoretic sometimes employed in the Cure of agues & externally as a discutient. It is used in Pharmacy to prepare the Carbonate of Ammonia &c.

It is employed by Soldiers & also by Tinmen for rubbing iron or Copper vessels before they are tinned

It is not possible to form an oxy Muriate of Ammonia or a Combination of oxygenated muriatic Acid with the Ammonia — for a part of the Ammonia only combines with the a part of the Muriatic Acid forming a common muriate of Ammonia — while the rest of the Ammonia is decomposed — its Hydrogen uniting with the oxygen of the Muriatic Acid so as to form water & its azot flying off in the State of Gas

Van Mons asserts that he has united oxygenated muriatic Acid to Ammonia but his method of doing it is unknown

Carbonates. The Carbonic acid is the feeblest of that Class and has a greater attraction for the alkalies than any other acid. It is this acid in their mild state united with alkalies, that is disengaged on the addition of any other acid, causing the effervescence which is familiar to every one, and the effervescence excited by the attraction of this acid in the form of Gas and combination of an acid & an alkali, that is usually considered as a test of the presence of acids or alkalies

- This acid is so feeble that it does not completely unguer the properties of the alkali to which it is united. Thus shewing that a solution of carbonated alkali changes a vegetable infusion turned to green the alkali also retains its familiar alkaline sensible taste - and this is proportion as they retain more or less of the Carbonic acid which it capable of uniting with them in different degrees -

Carbonas Potassæ - This appears in different forms according to the mode of its preparation - It may be obtained in a crystalline form the crystals being flatted Prisms of a wedge shape terminated by quadrangular pyramids

Its taste is alkaline but not unpleasantly so and in a very dry air it effloresces — But in the moist powdery form it is much more mild than the Crystals & deliquesces in the air forming what has been called Oil of Tartar per deliq: — This powdery salt in its taste and properties approaches much nearer to the nature of Potash for in reality it is not saturated with Carbonic Acid and ought to be called alkalinous Carbonat of Potash — If this be exposed to the air any considerable time it not only is liquified but acquires an additional quantity of Carbonic Acid

The Crystals or real Carbonate of Potash contain in 100 Parts — 41 of Potash — 43 of Carb. Acid & 16 of water. The alkalinous Carbonate of Potash contains 60 of Potash 34 of Acid and 6 of water

In an increase of Temp: it parts with its water by decrepitation and a small quantity of its carbonic Acid flies off. This almost entirely flies off in red heat in vacuo — It melts at a red heat

The Crystals may be dissolved in an equal Portion or rather more of boiling water & in 4 times their Wt of water at 60° — They generate some degree of Cold during their solution — But the alkalinous

Carbonate of Potash causes an increase of heat during its solution & this may be effected by a little less than an equal quantity of water

The Crystals of Carbonate of Potash may be recovered from this Solution by slow evaporation & Crystals are formed on Cooling — The alkaline properties of pure Carbonate of Potash may be recovered from its Solution by evaporating to dryness — agitating it so as to prevent the Salt from adhering to & acting upon the Capsule — or it may be separated the Potash appears and during its cooling Crystals will be deposited consisting of the Carbonate of Potash & the remainder of the Salt will remain dissolved in the Liquor having been deprived of a Portion of its Carbonic Acid & approaching still more nearly to the State of Potash

It does not [illegible] with oxygen in acid

Its action with the inflammable bodies Sulphur & Phosphorus are to be considered hereafter

All these Acids disengage the Carbonic during which an effervescence takes place which is now easily understood but was first explained by Dr Black but perplexed the Chemists before his time as they had been in the habit of considering the Carbonated al-

Alkalies as being in their most simple State.

— If a Carbonate of Potash be added to a Compound Salt as for instance to a Sulphate of Soda no Effervescence takes place but a double elective Attraction here takes place — forming Sulphate of Potash & Carbonate of Soda.

It is procured from the vegetable Kingdom as its former name implied by reducing the Vegetables to ashes and pouring water on these ashes so as to dissolve the saline matter — How it exists in the Vegetable is uncertain but probably combined with a vegetable acid which is dissipated during the Combustion — It is doubted whether it be the product of Vegetation or derived from the Soil — Some have said but without foundation that it was also produced by the inflammation

Experiments have been made to ascertain the different Quantities of Pure Alkali contained in different Vegetables but a great deal must depend on the proper mode of burning — One thousand Pounds of Fumitory yields 219 lbs of Ashes & 79 of Salt of Wormwood 78 lbs of Salt — Aspine 17 to a Pound & Fir only 145 to the same Pound

Plants yield more than Trees — These more than trees

leaves yield more than 3 branches and the boundary
them the solid trunks — but it is chiefly pro
cured from the bark of those on the shores of the Baltic
whence we have our chief supplies — the barks
are cleaned and divided by placing them in a
perforated board & pouring water on them which
is repeated to dryness — Potashes are also
brought in a similar state from Petersburg Dantzick
&c — These when purified a little by burning at
such of the impurities as are inflammable is called
Pearl Ash — it however retains a large
admixture of foreign salts and not easily made
to separate it from them — it must be dissolved
& earthy matter suffered to subside and then the
clear liquor very cautiously evaporated — The
foreign salts being less soluble than the Carbonat
of Potash & generally consisting principally of
the Sulphate of Potash are formed into Pellicles
on the surface & must be successively removed
— Sometimes when required for very nice Chemi
cal purposes this Salt is procured by decomposing
the Nitrate of Potash by charcoal at a strong
exhibition of heat — Potash procured
from the Tartar abounding so large Casks and

hence has been called Salt of Tartar

But all these products are alkalescent, in order to procure a saturated Carbonate of Potash expose these alkalescent Salts for a long time to Carbonic Acid Gas or to the Air of Atmosphere

a Speedier mode is by those Apparatus where a Solution of the alkalescent Salt is saturated by passing a stream of Air through Carbonic Acid Gas — but this Solution may then be vaporated & the Salt crystallized — but then the Salt is not so completely pure as by expressing Carbonic Acid Gas to hang over the Solution, another mode I shall mention hereafter

This Salt is of great Consequence to the Soapmaker and the Bleacher — the Soapmaker always extract from it its Carbonic Acid & then causticates by night for the sake of economy to be done by the Bleacher — It is used in dying and making Glass

This employed in Medicine to correct acidity in the primæ viæ & often for the sake of the Carbonic Gas it contains to engender nausea & vomiting by the gentle stimulus this Gas gives to the Stomach

It may be exhibited in ye com̄ form of ye effervesc^t draught or w^t is better ℞ of ye crystallized Carbonate of Soda being first swallowed let ye Patient take immediately after it as much vegetable acid as is known to be sufficient to saturate ye Salt.

This Salt supersaturated with ye Carbonic acid is employed with good Effects as a diuretic and Lithontriptic — The readiest way of preparing it is in Nooth's Apparatus — ℞ of the com̄ Carbonate of Potash being ~~[illegible]~~ dissolved in every quart of ye water & of Sulphuric acid and Chalk each two ounces for Gas to saturate this quantity being placed with proper precautions in ye lowest Compartment

But it is prepared in greater Perfection by some who prepare it for sale either by Cold or Pressure or other methods they do not chuse to divulge

It sh^d be kept in well corked Bottles in cool Places

~~This in the [illegible] of the [illegible]~~
~~[illegible]~~

This is in reality an acidulous Carbonate of Potash — we are indebted to Mr Colbourn of Bath

for a discovery of its alkaly in their complaints

Carbonate of Soda is commonly crystallized in fair and translucent Crystals of a Rhomboidal form and alkaline taste

100 Parts contain 21 50 Soda Carbonic Acid 14, 42 water 64 but sometimes 70 per cent of water It must therefore be effloresced to preserve it it should be kept in a moist place

By means of heat it undergoes a watery fusion at length is not fused and is at last volatilized a part of its carbonic acid being expelled always preceding means of Temperature

It may be dissolved in 2½ times its wt of boiling water at 60° & less than an equal quantity of cold water — It is easily recovered in form of Crystals

It has no action with Oxygen or azote Its action with Sulphur & Phosphorus will be noticed hereafter with Acids and Oxygenable Metals it will decompose it

It is the native fixed alkali of Egypt Syria & East Indies & especially Egypt furnishes us with large quantities of it

It is procured from a certain of Lakes in the Desert of ... when it exists dissolved during the winter running in and dry during the Summer

It is also procured by evaporating Sea Salt &c.

It is found in a peculiar crystallized State in Egypt — The Pike of Tunisiffes & in many part of Africa and is called Trona

These Strata are found to have an internal crystalline structure but differ considerably from the true Crystals of carbonated Soda — if these strata be heated they do not undergo the watery fusion — if exposed to a humid Air they crumble & fall into pieces so that the true Crystals require a moist Air these Strata a very dry one — and they are found to contain in 100 Parts 41.9 of Soda 34 of Carbonic Acid and 22.3 of water besides 1.8 of Earth so that it only contains about ½ of the ordinary proportion of water in the true Carbonat of Soda — In order to the Crystallization of these Strata they must have previously existed in a fluid state & that State must have been given them by Solution in water or fusion from fire and from the peculiarities this Salt discovers the Letter opinion seems to me by far the most probable, and if this information

We must extend to Rock Salt.

Soda is also found native in Europe — a Carbonate of Soda is found on Danish Coasts depending on a certain portion of Sea Salt in the water by the action of the Sun.

It is principally obtained from the ashes of Plants — in Spain from the Species of the Salsola Soda Salicornia and Salsola maritima — on the Coasts of the Baltic from the Fucus maritimus — and the Anabasis aphylla on those of the Caspian — Along with the Salicornia they also burn the Chenopodium maritimum on the Coasts of France.

The ashes of these substances being fused by the heat unite into masses called and this substance is called Barilla — Specimens from Carthagena and Nova Alicant — on the South Coast of Britain the Fucus nodosus is burnt with a peculiar attention affording what is called Kelp.

Proofs of burning these Vegetables, describes Specimens of Kelp from the Orkney Isles & Shetland

The Kelp contains besides the Carbonat of Soda (the ingredient we wish to obtain) Sulphate of Soda — Muriate of Soda — Sulphuret of Soda with Hydrogen — Charcoal giving to its Barilla a

And the Kelp is found to contain more of these ~~[illegible]~~ ~~other~~ adulterations contaminating ingred^ts than the Barilla — The Carbonate of Soda contained in the Kelp and Barilla is ~~[illegible]~~ purified by Solution Decantation slow evaporation and Crystallization

— The Carbonate of Soda is used to correct acidities in the primæ viæ and to form the Effervescent draught — it is used also very extensively and with excellent effects as a Lithontriptic either by mixing the Salt (after it has lost its water of Crystallization by Efflorescence) with Soap so as to form Pills — or what is much better in Solution supersaturated with Carbonic Acid — in which state it forms not an unpleasant drink and some of those who prepare it for Sale [illegible] prepare it in such perfection as to have a considerable degree of briskness. — If made in Nooths Apparatus ʒss may be added to the Quant^y of Chalk with Sulphuric Acid and ʒj for the Solution.

— It is used in the Arts in washing in Bleaching making Soap &c but in neither of the two last is it to be employed in the State of Carbonate — It is used in the state of Kelp in Glass making — It is also

employed in dyeing

Carbonate of Ammonia is commonly crystallized into octagonal Plates or Laminae if the Process be cautiously conducted — Its taste is slightly alkaline sharp and pungent Its odour penetrating and grateful

100 Parts contain 43 of Amm: 45 of Carbonic Acid and 12 of Water — Bergman — According to Kirwan there are 6 Parts of Ammon: to 13 of the Carbonic Acid

If exposed to the Air it neither deliquesces nor effloresces but is dissipated without Change

If exposed to an increased Temp it sublimes below 212 without change & concretes into minute slender Crystals

It dissolves in an equal or a little more of Water at 60 & in less at 120° — Water at 212 will volatilize a portion of it — a Saturated Solution made at a moderately elevated Temp in cooling deposits Crystals — but it is impossible to crystallize this Salt in the common way by evaporating the water — for the vaporific point of the Salt is lower than that of the water & it would consequently

be first dissipated by the Heat

— It has no action with oxygen acid or inflammable bodies

All ye Acids decompose it and both the other alkalies

This is sometimes used in order to procure a saturated ~~Solution~~ Carbonate of Potash — Dissolve lbj of ye com: alkalinous Carb: of Potash and add to it ℥iss of ye Carbonate of Ammonia — This mixture shd be made in a Retort and ye pure Ammonia freed from its Carbonic Acid will pass over into ye receiver wh. shd contain some water for its condensation

With the Nitrate of Potash it does not deflagrate merely because it is so volatile that ye requisite degree of heat cannot be applied — differing in this respect from ye Carbon: of Ammon with ~~[illegible]~~ other acids

Carbonate of Ammonia is rarely native It is found sometimes in Clay or marble in some springs and in ye Neighbourhood of Volcanoes — but is chiefly ~~produced~~ (not to say solely) ~~by~~ obtained from Animals & some Vegetables — by Putrefaction or by heat. The Veg: matter that yield most of it are those of ye Tetradynamia Class & of ye Cruciformes as Mustard Tobacco Fungi &c — but it is found most plentifully in Urine

It is procured from the Horns and Hoofs of Animals by distillation in an iron or earthen retort — a watery vapor arises first and afterwards the Salt contaminated with a fetid oil — some of it is dissolved in the water that came over the rest remains dry — This Salt is not found in the Substances themselves before they are made to undergo this Process but the Chemical Elements of wh. it is composed exist there & during the Process they enter into union — This Salt is also obtained during the distillation of Pitcoal for its Tar by a particular process — The Ammonia is is formed here as in the Soot of Pitcoal combined with Sulphuric Acid the ammonia being formed by a union of its constituent parts during the combustion of the Coal and the Sulphuric Acid arising from the Combustion of the Sulphur wh. the Coal contains

The mode of preparing the liquid Carbonate of Ammonia — or aq: Amm: in the Ph: Lond: is to mix Muriate of Ammonia ℥xij Pearl Ashes ℥xviij Water ℥i,xxx distil ℥xxij — In the Pharm Edin: Muriat of ammon: & Lixiva aa ℥ix water ℥xxiv are directed to be mixed and distilled to dryness

In this mode of Distilling to dryness there is little trouble but very great danger of breaking ye Retort, The residuum is Muriate of Potash. The proportions I use are Mur Ammon ℥j Pearl Ashes ℥x Water ℥xviij immediate action takes place and I draw over ℥x which forms a saturated Solution of ye Carbonate of Ammonia of uniform strength — and is ye same with that wh. ought to be kept in ye shops but we commonly meet with in a Solution not of ye Carbonate of Ammonia but of ye pure Ammonia diluted

Carbonate of Ammonia is sometimes used in Fever Cardialgia &c & very frequently as a stimulant to ye Nostrils in faintings &c and as a Rubefacient

The Phosphates ~~[illegible]~~ are formed in ye usual manner & exhibit ye common Phenomena on the union of their component Parts

Phosphate of Potash

Its Crystals are Quadrangular Prisms termind by quadrangular Pyramids — It is of an unpleasant Taste — persistent in ye Air easily crystallizable — exhibits nothing interesting with oxygen

arost or inflammable bodies and is applied to no use

Phosphate of Soda

Its Crystals are of a Rhomboidal form. Its taste is disagreable. Less than that of most salts. It effloresces in ye Air and application of heat to it fuses and on cooling forms a opaque glassy mass. but it undergoes no change and application of ye most intense heat.

It is soluble in three its weight of cold water and in rather less than an equal w^t. at 212.

It may be easily procured in ye form of Crystals it usually contains an excess of alkali. and it turns vegetable Colors green.

When on Acid with oxygen exist.

It is decompound by ye Sulph. Nitric or Muriatic Acid in ye cold. but it is not decompound Nitrate & Muriates if a sufficient heat be applied because the high Temp. weakens ye Attraction of ye nitric & muriatic Acid. but ye phosphoric Acid is fixed in ye fire.

It exists in bones. If ye bones be exposed to

the consistence of Syrup a Salt called Microcosmi is deposited containing a Quantity of Phosphate of Soda but more of the Phosphate of Ammonia & it is difficult to separate them from each other the Mode of obtaining it is to saturate the Phosphoric Acid procured in a way to be hereafter described to crystalize and crystallize — These Crystals are very easily crystallizable when slightly alkalinized — if there be an excess of acid they form a Salt called Sal perlatum

The Phosphate of Soda is under a purgative less disagreeable than most substances of the Class of Salts — It is given from ℥ij to ℥j dissolved in Beef tea or weak Gruel —

Dr Pearson introduced first into Medicine but was so ungrateful as to give a Statement of the mode of preparing it —

Phosphate of Ammonia

This was formerly called the Salt of Urine Its crystals are fluted quadrangular prisms with angles variously truncated — It suffers no change

from exposure to Air — and application of an increased Temperature it melts readily and the Ammonia flies off, leaving behind the Phosphoric Acid in its crystalline form

It may be dissolved in 5 or 6 times its wt of cold &
4 of hot water

It has no action with oxygen or azote

If heated with Charcoal the Phosphoric Acid is decomposed. — It is decomposed by any of the acids placed before it in the preceding Table — by Soda & Potash

It is found in certain animal fluids especially the urine mixt with Phosphat of Soda & called by Margraaf the microcosmic Salt or fusible salt and when heat is applied part of the Ammonia flies off the Acid is in excess & attaches itself to the Soda forming Salt or Acidum Perlatum

It is a most excellent Flux

It is sometimes decomposed by heat to obtain a very pure Phosphoric Acid

&c

Tartrites — These are formed by union with the Tartarous Acid & the union is accompd with the usual Phenomena — This Acid unites with the different alkalies in two different proportions

forming accordingly with each two different Acid
formed

The Tartrite of Potash — In mixing the
ingredients of which this is composed if to a Solution
of common carbonate of Potash you add a small
portion of the Tartarous Acid no Effervescence
at first takes place — as the Tartarous Acid at
latter itself first to such portions of the Alkali
as are not combined with Carbonic Acid —
On further addition of the Acid the Effervescence
ceases & Tartrite of Potash a soluble Tartar is
formed very soluble in water — but the acidulous
Tartrite of Potash is almost insoluble in water so
that if to a perfectly saturated solution you add an
additional quantity of acid a multitude of minute
shiny crystals in the figure and of acidulous Tar-
trite of Potash is precipitated

The acidulous Tartrite of Potash is a acidulous Tartar
called Wine stone — and is formed from the Juice of
the grape being found mingled in the sides of the Casks
most plentifully united by the mucilage with the kind
of stone and varying in its colour according
to the Colour of the Wine — It is found also
in the Must of the Wine before Fermentation —
It is purified by Solution Evaporation and Crystallization

with fine clay & whites of Eggs — the Solution is then evaporated and formerly it was the practice to suffer the Tartrate of Potash to form Pellicles on the surface wh. were skimmed off, whence it was called Cream of Tartar — but now the Salt is crystallized and this foolish name sh. to be exploded

The Crystals are white and opake four sided prisms terminated obliquely

100 Parts contain Potash 23 Tartarous Acid 57 Water 7 — the loss being sustained in the analysis

The taste is acid it undergoes no change from exposure to the air — If heated it decrepitates & at length undergoes a semifusion and the acid is entirely altered — The Tartarous Acid consists of Carbon & Hydrogen forming a base wh. is united to oxygen — and application of heat their arrangements are altered — the oxygen uniting to the ~~oxygen~~ Carbon forms carbonic Acid — and the Hydrogen uniting with Carbon in a different proportion

If the process be conducted in a close vessel, an acid Phlegm is first collected then a burnt oily fluid Carbonic Acid Gas — beyond a black charcoally matter containing Volatile Alkali in a small proportion

The residuum is the Salt in Potash with a quantity of carbonaceous matter

Dissolve the Salt water at 56 with distilled water by 8 ℔s of this crude Tartrite of Potash & if the water be kept boiling it will only dissolve 16 ℔s almost the whole of which separates as the Solution cools

This Salt with excess of Acid retains its acid taste and changes the colour of Vegetables to a red & it effervesces with the Carbonate of Potash

It has no remarkable action with oxygene with air — nor with the common inflammable basis

To procure the Tartarous Acid by decomposing this Salt we may be done by different processes but in that of Scheele Dissolve a quantity of the crude Tartrite of Potash in hot water — add slowly finely powdered Chalk as long as it is taken finely powdered Quartz being more pure than the Chalk till effervescency the lime of the latter unites itself to the Acid in excess forming an insoluble Compound — The Tartrite of Lime — which used to be called Tartarous Selenite — we examine in the sequel in Tartrite of Potash — after the Tartrite of Lime is decanted washed & separated from the sequel add

to the dry Tartrate of Lime an equal wt of the
pure Sulphuric Acid diluted with 4 times its
weight of water — The Sulphuric Acid having
a stronger attract. for Lime than the Tartarous
Acid has — combines with it forming a Sulphate
of Lime of no Solubility — & the supernatant liquor
contains the Tart. Tartarous Acid which may be
separated to the Consistence of a Syrup & crystallized

The supernatant liquor sometimes contains
an admixture of Sulphuric Acid, to detect this add
to a small quantity of it an equal quantity of Lead —
a white precipitate falls to wch add half a little
Nitric Acid if the nitric Acid dissolves it we may
rely on the purity of the rest of the Tartarous Acid
if not add a little more nitric Acid of the
Tartrate of Lime

Or if we wish to obtain the whole of the Tartarous
Acid — Quicklime may be used and then the alkali
of the Tartrate alone will remain in the supernatant
liquor

The crude Tartrate of Potash may be decomposed
by the alkali wch thereby used to be called Salt of
Tartar — by heat wch leaves the alkali combined with
a little charry Substances from wch it is purified

by Solution Filtration &c — 2d by Deflagrating
together in a crucible portion mixed 7 Parts of the
crude acid, 3 Tartrate of Potash & 6 Parts of
Nitrate of Potash — it remains in Carbonate of
Potash — Exp. The residuum is contaminated
by a portion of Charry Substance it may be sepa-
rated by the usual modes of effecting Filtration &c
— This is called the white flux
Exp — Result changes & crystals. Deliquesces
The crude Salt of Potash is used in the
crude State in dyeing — in Medicine when pu-
rified as a purgative Deobstruent Diuretick
The Tartrite of Potash or Soluble Tartar when
both of ingredients are saturated forming a neutral
Salt contain 43 of Potash 40 of Tartarous acid
and 17 of water in 100 Parts according to
the Crystals are transparent and colorless forming
a long quadrangular prism terminated by
a dunting — It undergoes no change from
Air — Its taste is saline & bitter —
when heated it is fused and the Tartarous
Acid is partly expelled — If distilled we obtain
a quantity of and Phlegm — a Brown oily fluid
a quantity of carbonic and Gas — and in the

that Potash united to a quantity of carbonic
acid matter will take fire when suddenly exposed
to the air

This Salt requires four times its weight of
water at a low Temp.e to dissolve it — in this re-
spect differing widely from the crudulous Tartrite
of Potash and hence denominated Soluble Tartar
— It is deposited in a smaller proportion of boiling water

A Solution of it if long kept becomes mouldy
on the surface from a change in the vegetable
acid it goes off during this Process

It is decomposed by all acids except the Tartaric
by the acetous acid in Part also tho a weaker
acid on the Principles already explained in speak-
ing of the decomposition in part of Sulphate by
the nitric acid — tho the instance before us
is a more remarkable illustration of it —
— when Tartrite of Potash is mixed with acetous
acid — there is an Attraction between the whole of
the Potash & the whole of the acetous acid — (but this
alone will be insufficient) there is also another
Attraction between the whole of the Tartarous acid
& two thirds of the Potash so as to form a radulous
Tartrite of Potash — and these two operating in

are greater than the quiescent Attraction already subsisting between the whole of the Potash and the whole of the Tartarous Acid - hence a partial decomposition takes place, but if the acetous acid be added to the acidulous Tartrite of Potash no change ~~takes p~~ is produced

If we wish to obtain the Alkali it may be done by burning as exhibited with regard to the acid: Tart. of Potash but this is never practised

The Tartrite of Potash is procured in one of two ways. - by saturating with Potash the ~~[illegible]~~ excess of acid in the acidulous tartrite of Potash as directed in the London and Edinburgh Pharmacopoeias.

Take Kali ℔j - Dissolve it in water ℔iij - add by degrees acidulous Tartrite of Potash ℔iij or till the Effervescence ceases - filter & crystallize

- Another mode is to separate the redundant acid by the addition of Chalk as in the process described for obtaining the acid of Tartar or Tartarous Acid - the neutral Tartrite of Potash remains in the supernatant liquor

It is used in Medicine as a purgative and has been supposed by some particularly serviceable in Cases of mania & Melancholia

Tartrite of Soda — Its crystals are Prisms of 8 Sides 10 Sides, — persistent in air crystals become very dry & then slightly efflorescent — & in taste much less unpleasant than most of the substances of this class —

If heat be applied it undergoes watery fusion and if the Temp. be a little elevated the Acid is destroyed — Its very Solute is rather more soluble than cold & in other particulars exhibits all some appearances as the Tartrite of Potash

If we wish to obtain the Alkali it may be done by burning it and the residuum is found to be a mixt of two Alkalies & Soda & Potash — This is one instance of a uniform Salt being formed by a Combination of two compounds — for this Salt is a mixture of two different neutral Salts — such as some portion of acid united to the two Alkalies but each Alkali saturated with a distinct portion of acid — This arises from the mode of its preparation — by adding to Soda the acidulous Tartrite of Potash so that the excess of acid in the acidulous Tartrite of Potash is neutralized by the Soda

— This Substance is used in medicine as a purgative & form. [illegible] unsalted

It is called Rochelle Salt from the place where it was made and Sel de Seignette from the name of the Apothecary who first prepared it

It is not strictly speaking Tartrite Soda being as before observed a compound Salt

Tartrite of Ammonia The ingredients of this is found united in the usual Phenomena and are capable of uniting in two proportions forming a neutral and an acidulous Compound — both are destroyed by heat It is always formed by direct Combination — for shows little more of it than its name & it is applied to no use

We now proceed to the Combinations of the Acetous Acid which in its pure state is highly volatile but admits of concentration to a considerable extent — It unites with Alkalis in the same manner & with the same Phenomena as the Acids in general

Acetite of Potash appears in whitish semi transparent masses of a foliated Texture from the arrangement of its crystals & hence the abbreviated name of Terra foliata Tartari — Its taste is sharp and penetrating — It has a great attraction for water

attracting humidity very rapidly from the air requiring therefore to be kept in air tight bottles. and very soluble in water — the solution sometimes may also when exposed to the air — the acid disappearing — If heat be applied it melts — and on cooling concretes into a friable mass without change — If heat be greater than barely sufficient to melt it — If greater heat be applied in a close vessel a complete change is found to take place, first evinces a portion of water with a burnt acid — then a burnt oily fluid — Carbonic Gas & Hydrogen Gas are collected and at residuum is Potash united to a carbonaceous principle matter discovering it to take fire at and during temp.re Contact of air — If heat be suddenly applied this acetate of Potash takes fire and burns with a copious flame in consequence of the acetous acid it contains the of which is not saturated with oxygen — During this Process the acetous acid is entirely changed in its nature — Alkali remains in the State of Carbonate — It may be separated from its solution by Crystallization

It exhibits nothing interesting in its relation to oxygen and a inflammable bodies

It is decomposed by the different acids before it in the table and this is sometimes practised with ye Sulphuric Acid to obtain ye acetous acid in a concentrated state

Introduce a portion of ye strongest sulphuric acid into a tubulated retort add to it when heated an equal weight of ye dried Acetite of Potash, distil in a sand bath till you have obtained half as much acid by weight as you employed of ye Acetite of Potash

To obtain ye acid with a still smaller proportion of water Mr Lowitz of Petersburg employs 8 Parts of ye Acidulous Sulphate of Potash & 3 of the Acetite of Potash — both as dry as can be procured and subjects ye mixt to distillation — Here the Sulphuric Acid in excess detaches ye Acetous —

The Alkali may be obtained by dissipating the acid by heat

This Salt exists in some plants but is ~~found~~ obtained always by direct combination

The Potash is saturated with ye Acetous Acid & ye watery part evaporated till ye dry salt remains wch is rendered impure by the oily and mucilaginous

matters contained in the Vinegar — These impurities are burnt and by heat very carefully applied rendering them insoluble in water the salt is redissolved filtered and evaporated — If it is impure still, so that it does not totally deliquesce in Proof Spirit — the London College direct that it be purified further by mixing the whole of it with proof spirit suffering it to subside and having decanted the clear Solution to draw from it by Spirit by distillation, but this process will add greatly to the trouble and expence

It is used in Medicine as a diuretic and certainly has some effect but not so considerable as to entitle it to the name of Sal Diureticus

Acetite of Soda — is also called Sal Digestivus minerale it is made by direct combination in the same way as the Acetite of Potash It is not so deliquescent as the preceding soluble in water It is similar in its general qualities — and it is sometimes prepared to get the Acetous acid in a concentrated state by its decomposition

Acetite of Ammonia — This has a hot strong penetrating taste is very volatile and rises

at a temp. not much elevated without change Hence it is difficult to procure it in a solid form as only a little of the water is first expelled by the heat before the Salt itself begins to ascend

It may however be obtained in a solid state by a double elective Attraction — Mix Acetite of Soda or of Potash — with Muriate of Ammonia both as dry as possible — apply heat to the Retort and you obtain Muriate of Soda or Potash and Acetite of Ammonia in crystals of a needlelike form — All the Acids before it in the Table wd decompose it. It is no where found Native but is prepared for medicinal purposes extemporaneously by mixing the Acetous Acid with the Ammonia —

It is used as a Diaphoretic & diuretic

— By combinations of the Alkalies with the Acetic Acid Acetates wd be formed tho some are of opinion that this Acid in its most common state is acetic but to this I am not disposed to subscribe

We treat next of the Combinations of the Boracic Acid — This is a very weak Acid and requires to be dissolved in hot water in order to effect a combination of it with the Alkalies

Borate of Potash. This combination is recently made and its properties have not been investigated

Borate of Soda. This appears in regular Crystals — six sided Prisms two of the sides being flatter than the rest and terminated by a three sided Pyramid — Its taste is slightly alkaline by exposure to the air it slowly undergoes a spontaneous Efflorescence, 100 Parts contain according to Bergman 17 Soda 34 Boracic Acid 49 Water — When subjected to heat it undergoes the watery fusion & on increasing the Temp. it is puffed up to a spongy mass of prodigious size Evap. exhibiting this — It then becomes what is called burnt borax. When the heat is still greater the Borax melts into a viscid Matter of great ductility — It cools without change into a vitreous transparent mass — it undergoes no change from any heat we can apply to it but is a very powerful flux

It dissolves in 12 times its wt of ~~boiling~~ water at 60. and a little more than 3 times its wt of water at 212° — and during its cooling it is deposited in Crystals — It tinges Vegetables green and Acid is scarcely of power sufficient to overcome

the alkaline Quality of the Soda &c:

The soda may be united with a larger proportion of the Acid by combining equal weights of the Salt in its common state and the Boracic acid

If 10 Parts of anhydrous Tartrate of Potash be mixed with four of the Borate of Soda & boild in a quantity of water just sufficient for their solution & then evaporated to dryness — the solubility of both the ingredients is greatly impaired & you obtain a viscid mass deliquescent in the Air and which has been used especially in France as a purgative under the Name of soluble Cream of Tartar

— Borax or the Borate of Soda is decomposed for the sake of its acid by dissolving it in about 3 times its wt of boiling hot water then adding to it its wt of strong sulphuric Acid diluted with its bulk of water — no remarkable Phenomena are observed but on cooling the Boracic acid is deposited in subsequent Crystals

— This Salt may be decomposed for its alkali by adding Potash but this is never practised

— Boracic Acid on account of its fusibility in the fire may be employed to decompose Metallic oxides and muriates at a high temperature

as to its Origin It is always brought hither from the Eastern Coasts — It is found in Persia China Thibet and also in Tuscany —
It comes to us from the E. Indies in wt it is called Tincal Paste surrounded by an oily matter like the dregs of Milk in cream — a Particular acct is given by Mr Saunders of the mode in wch it is obtained from the Lake of Thibet by in the Ph: Trans: V. LXXIX

This Lake is 20 Miles in Circumference and tho their Salt has been dug from it a great many Years there seems to be no diminution made Cavities are filled up This is remarkable

It was a long time supposed in Iceland by a secret process but the practice of it is now carried on in this Country

It was said some Years ago that it might be artificially manufactured but this seems to Mr Morveau is a Falsehood

In Medicine it is used to cleanse & cover from ulcerous appearances &c It is used in soldering, giving a covering to metals during their fusion wch it greatly promotes, as also the fusion of some earthy bodies and in the

making of some fine sorts of opake to counterfeit gems

Borate of Ammonia may be formed by direct Combination Its properties have not been investigated nor is it employed for any purpose whatever

Capability of forming acids, when comp^d
with and alk

Earths

The earthy bodies come next to be considered & form a Class of objects peculiarly interesting as they constitute so large a proportion of the mineral world — as many of them are used in the Arts and as all are important in agricultural researches

The Earths are found to be uncatching infusible little soluble in water — unflammable — of a specific grav: not exceeding 4½ compared to water as unity — dry brittle colorless and for the most part insipid ×

All these Characters are not universally applicable but exceptions are by no means numerous

Varieties and numerous as these sub stances may appear — only a few not exceeding seven or eight in number are simple Earths — all others being formed of these in various degrees of Combination — and the nature of these Combinations is a subject which has lately afforded an ample scope to the investigations of the mineralogist

Before entering more minutely on the Subject I must premise a few facts relating to the mode in which these substances are distributed & some inferences that have been drawn from this distribution respecting their original formation & present arrangement.

— The Earth at one time delights us with her extended Plains — at another time she astonishes us with her lofty mountains — we shrink from the depths of her impenetrable Caverns — tremble at the craggy rocks which threaten to overwhelm us — On a nearer view we find the surface every where covered with an heterogeneous mass of decomposed Soil consisting of earths and stones mixed with the remains of animal & vegetable bodies in a State of putrefaction sometimes extending to the depth only of a few Inches but in other situations to that of 100 Fathoms

— On penetrating through this superficial covering we arrive from the decay of stones earths & animal & vegetable bodies in succession at a more compact indurated stony substance which is universally found to be dispersed in Strata

Pr cot. deviate most from d planes of d horizon

to whatever depth we descend.

These strata are sometimes discovered to be of amazing extent and constantly to preserve their parallelism to ~~each other~~ each other. They are found of every diff.t inclination from a horizontal to a vertical and ~~these strata are bounded by~~ meetings are of every degree from a slightest undulation to a circular flexure.

Frequently too we see the evident marks of disorder of fracture and of dislocation — corresponding strata being found abruptly broken & one termination many inches feet or fathoms below the other.

These strata &c. are most contained one under another and these more horizontal are of superior in their stratification.

These strata are of most undulated & less plane declining from a plane of a curve & vice versa —

Hence the strata have been divided into two orders ~~or classes~~ primary and secondary

— If by these terms nothing more is intended to be conveyed than that one is

prior to & then in existence — This is a truth of wch we have the clearest evidence, nay more it is evident that they must have been prior in their existence by periods incalculable but if by "primary" we mean to denote & they were coeval with the Globe of the earth itself we launch into questions highly hypothetical & visionary.

— The 2d way Strata are much later in ye era of their existence at least in ye state in wch they are now presented to our observa. They are of a less indurated texture, & they are composed of a congeries of Particles of irregular forms wch appear to be ye fragments of some former regular masses of stone that had previously existed intermixed with ye remains of animals & vegetables of ye marine tribe

These masses of apparent ruins are sometimes of prodigious extent & they are found in ye most elevated situations of ye globe as on ye Andes & Alps 7000 feet high and on ye Cordeleras &c at no less than 14000 feet from ye level of ye ocean and they are found at ye greatest distance below ye earths surface

to which human perseverance has hitherto
penetrated

These animal remains are said never to
have been found in the primary strata &
hence the coevality of them with the earth
globe itself have been inferred, but this position
tho generally is not unconditionally true and
one instance to the contrary will be sufficient
of which a multitude are not wanting, is
sufficient to overthrow the basis and
its superstructure

In all Countries immense masses of Stone
are found forming rocky mountains or
bodies of a smaller size which exhibit no distinct
marks of Stratification — These if primitive
by violent precipice break into angulated blocks
and their internal structure exhibits a congeries
of crystals variously adjusted to each other —

Specimens Granite Whin stone

Where two kinds of Strata of previous
& secondary are found in contact the primary
Stratum is found more indurated & disordered
than usual — and sometimes a vitrified
mass is interposed between the contiguous terms

nature of ye primary Stratum — frequently &c & often too these terminations on ye diffᵗ sides of the interposed masses are found at a different level this is called a trouble or a shift — In ye Coal Mines near Newcastle ye shifts amount to nearly to 70 Fathoms

These are the two grand modes in which stony bodies are distributed — and instead of calling them primary and secondary we shall call them stratified and unstratified

— Both these are sometimes penetrated by — matters of a different nature called veins — presenting the appearance of a crack filled by a stratum of a different nature — Specimen — This interposed stratum varies in its thickness from a line to several feet & then it constitutes wᵗ miners call a Dyke — These consist sometimes of metallic substances sometimes of crystallized earth or spar but at all times they exhibit more or less of a crystallized appearance

— Many Hypotheses have been formed to account for these Phenomena and these have been called Theories of ye Earth — names wᶜʰ it must appear not a little unsuitable when it is recollected

(a) covering the surface of the earth – the internal parts of the Earth being left empty Cavities

(b) The heaviest being deposited first forming the primitive unstratified mountains of granite

(c) The solid parts rent and the chaotic fluid sunk into the deep left empty Cavities – depressions were formed and the tops of the granite mountains first appeared as dry land while the waters became fit for the subsistence of marine animals — The waters had now subsided to 8500 feet above their present level and this altitude is specified because Mr. Kirwan asserts that no marine impressions are to be found at a greater height than this – "but that the waters de

that we have not penetrated to the 1000th Part of the Earth's radius

I shall briefly notice two of ye most modern of these Theories — that of Kirwan the aqueous theory or the theory of ye Neptunists and that of Dr Hutton — the igneous theory or that of the Vulcanists

Mr Kirwan boldly goes back to ye Creation & ventures to hazard a conjecture ~~[illegible]~~ of the state of ye material world even when it existed in a Chaotic mass — He imagines an immense intermixed mass of fluid consisting of water metals earths inflammables(a) — between wch a chemical action taking place disengaged elastic fluids and hence the Air of the Atmosphere — that the Earths were deposited in a crystalline form at ye bottom of this fluid but irregularly(b) and that by this crystallization much Caloric was generated and oxygen evolved from ye decomposition of water — hence a Conflagration arose(c) ~~The mass became solid and cracked porous into numerous fissures into which the water rushed [illegible]~~ — but that the waters of ye ocean were many ages before

(a) and that during this period there was time for the depositions &c

(b) Hence at length a great part of ye Earth was left dry, as ye remaining waters excepting those wch still retain that form — retired with thes secondary strata to these deep recesses

they subsided to their present level and ~~cease~~ the deposition of marine animal & veg: substances - the remains of these organized bodies he supposes to have been mixed with the ~~strata~~ remains of the Chaotic fluid and then floated by the water till they were deposited in 2dary strata(b).

- He further supposes the Earthy matter to have been indurated by crystallization & concretive attraction & that ye particles were connected by ye infiltration of fluid between their crevices and substitution or the removal of some to make way for others by the fluctuation of ye water

- That this mass was subject to various accidents from eruptions volcano's &c &c wh. have caused various fissures in every direction & that these fissures have been filled by infiltration by wh. crystalline veins have been formed

That during the Deluge shells were conveyed to the highest mountains and ye bones of animals to climates where they could not have existed

- I may just observe that this theory only explains ye relative position of ye primary & 2dary strata - the notion of a Chaotic Fluid involves many chemical incongruities It is difficult

It is difficult to account for consolidation in the way Mr Kirwan has supposed and the German Chemists who seem most part adopt the Neptunian theory do not resort to the Caustic fluid

D Hutton imagines that the Strata now known have been formed from loose incoherent materials proceeding from the ruins of a previously existing world — That these materials were regularly arranged by the previous water — That these Strata were heaped one on another by which they were subjected to amazing pressure, besides that arising from the weight of superincumbent matter — Thus he imagines the whole became exposed to the action of an internal fire by which it was softened compressed and consolidated — That by the expansive force of the water these Strata were raised from bottom of the ocean so as to form land while the waters necessarily receded into Mediterranean a Portion of the earthy matter melted and burst forth under and at the Strata which is the cause of the derangement of veins the dykes and the unstratified masses observable among them

that there interstitial substances being in a melted state crystallized as they grew cool — that the surface of the earth became habitable from the formation of soil by the decay of mountain stones &c

That the waters of the sea are constantly washing away the loose matter from the land that there are conveyed to the bed of the ocean every day to be elevated by the subsequent force of the internal fire so as to form a new world — That this decay is constantly going on, & hence arises the increasing elevation of mountains from the parts around them being borne away in this universal decay & that to this & the great operations and convulsions of nature contributes

This Theory is prest with great difficulties than few any other that has been proposed & I shall have frequent occasion to refer to it hereafter

— The simple primitive elementary Earths of which all others are formed & into which they are resolvable are at least six in number & to these perhaps three others may be added — Viz. Lime or calcareous Earth — Baryta

Strontita Magnesia. Alumina & Silica — besides these may be mentioned Zirconia or Jargonia — Glucina Augusta Gadolinite

— All the varieties of Earths arise from yᵉ number proportion combination & arrangement of these elementary Earths — and sometimes after they are found united to saline or metallic bodies

These Varieties have been classed according to their external Characters of Figure, Color — transparency — — hardness — facility of fracture texture — specific gravity smell taste & touch feel and also according to their internal and Chemical Qualities — that Classification is yᵉ best wᶜʰ unites both these — the Classes and Orders being taken from yᵉ chemical Characters the lesser subdivisions from the external Characters — but to distinguish all the varieties where the shades of difference are varied in every different degree is necessarily a task of very great difficulty — we shall adopt this blended mode of Classificatⁿ as Mr. Kirwan has done in his Mineralogy and I propose to explain the Chemical Qualities

of the different elementary earths, & notice other fossil productions into wch they enter as the most
copious & characteristic & valuable ingredient

Lime a Calcareous earth is no where found
pure — but combined with another earth or what
is very general with an acid — so as to form an
earthy Salt and the acid of which most frequ
combined with it is & Carbonic — as in Chalk
Limestone marble &c

— The carbonic acid may be expelled by heat so
as to leave a calcareous earth pure —

Its Specific gravity is 2,3 — white when pure
of a dry meagre feel brittle easily pulverizable
and of a strong lixivial alkaline taste — It is
corrosive from an attraction between it and some
of the component Parts of an animal or vegetable
body wch it comes in contact

When exposed to the air it swells cracks
& falls to powder from attracting moisture & humidity and carbonic
acid from the Atmosphere

— It sustains without change the most intense
temp wn that of the Solar rays collected in a focus or
that of charcoal ignited by a stream of oxygen Gas
If it is impure fusion takes place from an action

between it and ~~oxygen~~ the substance com-
bined with it Lime it is sometimes employ'd
as a flux It has a strong Attraction for water
& presents particular Phenomena when this fluid
is mixed with it — It grows warm — swells
cracks & is broken down into small particles —
and throws out Vapour in a copious Stream
& there remains a perfectly white dry substance
This is called slaking Lime and when done in
a dark Room is a faint luminous appearance
— The heat excited is sufficient to inflame wood
as in the destruction of Carthage or ~~coin~~ of Ships
containing it has sometimes spread —
— This evolution of heat is ascribed by
the Generality of Writers fluid to a con-
crete form & energy giving out caloric — Some
suppose it to arise from a diminution of Capa-
city that ensues during the union — by others
it is imagined to depend on attraction in the
chemical Attraction — It was formerly con-
jectured to be caused by the evolution of igneous Par-
ticles which had been removed by the Lime during
its burning

Lavoisier and Laplace found that one

& water uniting (in ye proportion of Lime 16. water 9) was sufficient to melt 17½ parts of Ice

~~This powder is heavier~~ Dr. Higgins endeavoured to avail himself of this fact in determining if caloric were ponderable — & he says that on weighing it when hot & again after it had grown cold a grain was found to have been lost but this is not to be relied on as a satisfacy: exp.

The powder is heavier than ye lime before it was slaked by ye wt of ye water absorbed & Lavoisier showed that 1000 parts of Lime gain 2281 of water ye powder still remaining dry —

This powder is called Calx extincta in contra distinction to ye Calx viva. ye water may be expelled by a strong heat and the lime is the same as before ye slaking

Lime is more readily slaked by adding ye requisite quantity of water than by adding too much

Lime is employed in conseq: of its great attraction for water to exsiccate animal & veg: substances to preserve salts from deliquescence &c.

Slaked Lime is soluble in water tho it requires a great ~~deal~~ quantity — ye Solution formed is called lime water — when more lime

is added than the water can dissolve it forms wt
is called milk of Lime — To form its solution
in d water it shd be agitated at intervals for
3 times — filtered in a covered vessel or decanted
— water saturated with it is remarkably trans
parent & colorless — it has a pungent alkaline
taste and changes vegt colors &c.
— Water dissolves about 1/700 in d ounce measure
to Higgins 1/700 parts of its wt of lime
Limewater shd be kept in close vessels
for if exposed to the air it undergoes a remar
kable change — absorbing rapidly carbonic acid
& forming a Pellicle of carbonate of Lime on
its surface which it loses its former taste &
qualities
Lime has no action with oxygen azot or
hydrogen — It unites with Sulphur and Phos
phorus into peculiar compounds to be here
after made known to you
It has not attraction for alkalis but a
very strong one for acids, wth wh it
it unites to mutual saturation and neu
tralization — During this union a great de
gree of heat is generated than if alkalis were

were employed instead of Lime

Eff.ve with Sulphurous Acid added gutta-tatim and very cautiously to Lime — & heat raises the Acid to a state of distillation and it is dispersed in fumes

Eff.t Solution of Lime in Muriatic Acid dilutes into a clear transparent fluid

Then are called earthy compounds with a Base of Lime

With some Acids Lime has a stronger attraction than alkalies have — with others it has a weaker — but always stronger than the volatile Alkali or ammonia

Carbonate of Lime exists as a very copious natural production & is commonly called Calcareous Earth — Various Specimens exhib.d

The Characters assigned to calcareous fossils are insolubility in water never striking fire with steel — effervescing with acids — being converted into Lime (or Quicklime as it is called) by heat & not exceeding 3, in specific grav.

They are sometimes found in extensive strata, in every kind of duration from a transient with every variety of texture & in every state

state of Induration from Specimens of Chalk & of lime stone from the Irish Coast

We meet with it of various hues - red, grey bluish &c some of the beds flat and horizontal others in elevated & contorted strata - the last are called primary the horizontal secondary -

When indurated sufficiently to bear a fine polish it is called Marble - sometimes the marble is colourless as in the Western Isles - in other instances of every different shade & colour from the admixture of foreign matters -

Often we find the remains of organized bodies and sometimes they constitute almost the whole substance - On many occasions they are found filling up veins and in sparry forms more or less transparent & coloured and always of a crystalline texture - the fragments uniformly being found to break into oblique Parallelopipedons - sometimes they are quite transparent - Beautiful Specimens from Iceland wh. exhibits the double refraction wh. is not thought to have been satisfactorily explained even by Newton

When the veins have a cavity in them, there

calcareous Spars exhibit a regular form of Crystals — The primitive form is the Rhomboid — sometimes they appear in the form of a perfect Cube — often pyramidal or a pyramid terminated by a prism — which is called the Dogtooth Spar — In the silicious crystals the sides and angles of the Pyramid and the Prism correspond but never in the calcareous crystals

Stones are of a Cubical shape — Mineralogists enumerate 40 or 50 different shapes

— To discover calcareous Stones the Chemists rub only a good knife and on and by the first he finds the calcareous Spar a Stone adhering a scratch — by the Mass he excites an effervescence

— In solution of calcareous Earth exists in mineral waters and from them is often deposited — Those depositions of the Carbonate of lime are called calcareous incrustations & petrifactions — They are usually modelled to the form of the substance over which they are deposited — the matter of the Substance being washed away and the calcareous matter supplying its place which is called substitution — Specimens of masses of Reeds, Birds nests &c — There are

There are several remarkable springs of this kind particularly at Knaresboro' in Yorkshire and near Hamilton in Scotland — When these waters flow over the surface of rocks they gradually form incrustations of a foliated texture which are susceptible of a high Polish and are greatly prized for their ~~tree~~ beauty When such a solution passes thro' the crevices of the roof of a Cavern and drops down they form Stalactites — Icicles or dropstones — and some parts of Derbyshire afford the finest Specimens of this in the world as the water evaporates and there is consequently an accumulation of earthy Particles — When the drops fall directly to the bottom of the Cavern these masses are formed of a different form as that of a Kidney and called Stalagmites — this process it is evident can only take place in a Cavern exposed to the air —

A very copious source of this earth is the testaceous crust. which are formed on animals especially marine Animals which are mostly composed of the Carbonate of lime & animal glue — tho' often with some Phosphate of Lime — Not only common shells but Lythophytes Corals Corallines tubipores millepores madrepores and that most curious production the Brain stone brought from the East Indies are formed of Carb: of

of Sinai and it is now clearly ascertained that they are formed by animalcules which inhabit them — often we find these fossil animalcules — Specimens from the Island of Ascension and the Hebrides

We know this Earth frequently combined with Shells and the use of opinion the most valuable ingredient in the Composition — these are called Marles — Shell Marle found at the bottom of ponds — Clay shell marle — Clay Marle — Stone Marle — various Specimens — The stone marle when exposed to the Air loses its hardness and is disposed to break into small Particles

The general & most received opinion respecting the origin of these fossils is that they are formed by the accumulation of the Testaceous Coats of marine Animals — and often we can distinguish clearly the fragments of Shells (Spec) sometimes entire Shells — in some instances the impressions of fish (Spec. from near Verona) & sometimes of land Animals

Specimens of the Cornu Ammonis — of the impression of the Cornu probably of the Ammonites brought from Gibraltar

and of a few Quadrupeds — Similar Earths are found on the shores of Dalmatia and ye Adriatic — these last however as Mr Imry has shewn are of recent production — the calcareous earth having been consolidated round bones of land animals wch had fallen thro ye Crevices & they are not to be considered as forming a Part of the solid strata of ye Globe — These Strata must have met with great derangement as is evident from their disordered appearance — These animal remains are sometimes found in marble but never in crystallized marble — wch as I have stated must once have been in a fluid state —

It is still a controversy how these strata were formed, some say they have been dissolved in water and urge the stalactite as an Instance but the stalactites very unlike the calcareous strata we are mentioning have been exposed to ye action of ye air & their humidity evaporate — Others with Dr Hutton are of opinion that that the agent of consolidation is fire — It is objected that this is impossible for that the Carbonic acid of lime wd fly off in such an intense temp

but this objection is obviated at once if we recollect the ~~pressure~~ incumbent pressure — for by pressure even in our comparatively weak instruments we can prevent ye escape of elastic fluids

— It may be asked if this be the only source of the carbonate of lime? probably not — Possibly some of the Earths wh. we call primitive may have been of ye calcareous kind, the marine animals may derive it from ye waters in wh. they exist.

1. ~~Sub~~ Carbonate of Lime if pure is insipid mild and inert with regard to ye animal Economy insoluble in water & contains in ye 100 Parts 55 of Lime & 45 of ye Carb Acid accord. to Kirwan this acid is expelled by al others with Effervescence and by this we detect marles and Calcareous Earths but not to be deceived by ye air contained in ye pores of stones & wh. sometimes rushing out gives ye appearance of Effervescence we must first wet ye subject of ye experiment and use the diluted muriatic acid or nitric acid &c.

100 Grains of ye Carbonate of Lime or Chalk wh. is very convenient for procuring carbonic acid yield about 80 or 90 cubic Inches of gas —

When heat is applied to ye Carbonate of lime

in the State of Span a Marble it decrepitates & some emit a phosphorescent light an ammoniacal smell is perceptible Carbonic Acid is expelled and Lime left in the same or some other State

The purest Lime is obtained by placing alternate layers some inches thick of fuel & of Chalk or Marble in a coal furnace & subject them to a strong heat but not much beyond Ignition. This is done in a large way in lime kilns or draw kilns which are of a conical form with the apex downwards. It is an important improvement to affix a Dome to the top wh may be raised to any desired height & the temperature may be managed at pleasure

In burning it loses 40/100 of its weight it shd therefore be burnt at the Quarry to save the expence of Carriage

Pure burnt lime is light porous somewhat sonorous & does not effervesce with acids

Lime when moist absorbs carbonic gas from the air it shd therefore be used when first burnt or if not it shd be kept dry

This property of lime of absorbing carbonic acid

with such rapidity is often taken advantage of to detect the presence of Carbonic Acid.

Exp. Expire for some time into lime water & it becomes turbid & Carb of lime deposited

It is curious that if an excess of Carbonic acid be added the carbonate ~~oxid~~ of Lime is again dissolved — forming a fluid analogous to many mineral waters — petrifying waters &c.

Lime has a stronger attraction than any alkaline body for Carb acid and when added to a Carbonate of an alkali the Lime becomes a Carbonate and the Alkali is left pure or in a caustic state — and as we commonly get the Alkalies in the state of Carbonate — it is by Lime that we deprive them of their Carbonic acid — Exp. Take of lime well burnt and bruised ℥iv — slake it in ℥xiv of water raise quite to a boiling heat — a violent ebullition takes place — when this is completed add by degrees ℥ of Carb: of Potash in its alkalescent state ℥iij agitating after every addition to prevent the concretion of the alkali — to filtrate the liquor introduce a pebble into the throat of a funnel and cover it with sand or when the liquor is cold a moistened piece of linen may answer the purpose & pour on it

the whole of the mixture — In this case very softly so as not to disturb the sediment a quantity of water and continue the filtration for some days Take you have obtained Extract
This is the aqua Kali pura of the L. Ph. the aqua Kali pura Caustica of the Ed. Ph. It shd be colourless and inodorous — When evaporated to dryness in vessels of Iron or Silver, cut into strips and placed in a close Vessel — you have the pure Potash — the Kali purum of the Lond: & Caustic Comm: Accession of the Ed. Ph.
This is rarely perfectly free from Carbonic Acid — because according to Berthollet the Quantity of Alkali at length becomes so great in proportion to the acid as to compensate for its weaker Attraction — & thus time the it has a stronger chemical Object is unable to separate it — a part may be its effervescence with an acid or causing a mild precipitate in Lime water — if so a small quantity of Lime may be added to the liquor from before evaporation & it may be decanted
Lime decomposes the same way the Carb of Soda — and Carbonate of Ammonia but

is never employed thus for 1st Coal of them because the ammonia may be procured in a pure state by an easier process

The rationale of these Changes was entirely misunderstood till the time of Dr Black who explained them in 1756 — See 2d Vol of Edinburg Library Essays

Carb. of Lime is used to procure the Quicklime for mortar and for manure

Sulphate of Lime — Lime readily unites with the Sulphuric Acid — with evolution of heat and forms an insoluble Compound — If a lump of marble be thrown into the diluted Sulph. Acid the effervescence ceases before the entire decomposition has taken place for the crust that is formed round the lump of marble by the Sulphate of Lime prevents the further action of the Acid on the interior parts — Hence this Acid is an unfit test for discovering calcareous Earths —

This earthy salt is a natural production under various modifications of Gypsum or Selenite and forms the Stone employed in engraving Busts &c. It sometimes exists in a blended state but Stone in which it is easily distinguished by its

softness so as generally to be readily scratched by the nail — in this it resembles the Steatites but they have a greasy feel

Its specific gravity is from 18 or 19 to 23 compared to water as 10

We have it of various textures granulated — granulofoliated — of various colours — sometimes perfectly white & sometimes transparent — at other times of a very different hue

It is found near Glasgow takes a good Polish and is the true alabaster — sometimes it is of a parallel or transverse fibrous texture — the fibres are sometimes gradually flattened & pass into the Plates called Specula, & improperly Muscovy glass — for the Mica is used instead of glass & is elastic but the Sulphate of Lime is not elastic — It appears crystallized of different Shapes in clayey and marly strata often in the shape of truncated hexagonal prisms of Rhombi or sometimes of Cubes — sometimes in a powdered state called farinaceous Gypsum

It forms in Solution petrifying water — and it exists in Sea water and forms the Panscratch — It contains 2/9 of water of Crystallization wt

it loses on an increase of heat parting [illegible] becoming friable and opake — Powdered & heated in an iron Pot it seems to boil like a fluid and if the heat be not greater than a red heat there is left behind a white Powdery matter consisting of 59 acid to 41 Lime — This has the property when mixed with water of growing warm and in a short time consolidating — and is daily employed in forming various ornaments under the name of Stucco — Its consolidation is owing to its resuming the water of crystallization — and the heat depends on the transition of the water from a fluid to a solid state — Some have supposed it to depend on a mixture of Carb. of Lime — this however is a mistake; such an admixture may improve it but certainly does not communicate these qualities. It is of importance that the heat be no greater than is sufficient to produce the change, for if too great it does not consolidate so firmly & cracks —

It bears when in this state the most intense temperature of our common furnaces but yields to that excited by oxygen Gas but even then it fuses sparingly

Water dissolves of the Sulphat of Lime 1/500.

of it weighs at a boiling heat and when this Solut.n is evaporated it yields a Sulphate of Lime in short crystals of a silky fibrous texture and if the water contains any sulphuric Acid a Dissolution of Sulphate of Lime will not even evaporate by

None of the acids have so strong an affinity for the Lime as sulphuric and to decompose this Salt we may employ charcoal reddened at a strong heat and we shall obtain a sulphuret of Lime

Potash and Soda in a State of Carbonate readily decompose it by a double elective Attraction

It is employed as a manure and said to be an excellent top dressing to grass Lands but is chiefly used for forming moulds statues ornaments &c called Stucco It is burned in Kilns and is used for coarse mortar It mixed with Sand it is used to join bricks Stone and floors with a jointing It is called Plaister of Paris Gypsum Selenite &c

Nitrate of Lime presents little interest Its solution is colorless and by evaporation yields rhomboidal crystals Deliquescent in damp Air It dissolves little Alcohol Nitrates, It is nowhere a natural production but made up in Compositions for the manu

facture of w Nitr — It is applied to various

Muriate of Lime Muriatic Acid readily unites with Lime either pure or w Nitr of Lime — The Solution is transparent colorless and yields by evaporation long quadrangular prismatic Crystals — If evaporation is carried to w consistence of a Syrup it concretes and if it is cooled in close vessels it concretes into a crystalline mass of considerable hardness — In winter on Shortest evaporate to w Sp. gr. of 1450 in Summer to w of 1490.

If evaporated to dryness it is of a very white color and bears an intense temperature

It is very deliquescent in w Air and absorbs water very rapidly hence it is often employed to absorb humidity from w Air — and to dephlegmate spirituous liquors as in w Distillation of w purest alkohol

When reduced into fine powder from w mass and mixed with same powdered Ice it generates intense Cold — This is w Salt employed to procure Mercury — for this purpose it must contain the largest possible quantity of water of crystalization — In winter we therefore evaporate to w consistence of w thinnest Syrup w^h will concrete — must then be pulverized and kept perfectly dry

In Summer on acct of the Heat of the water in the crystals it is requisite to evaporate to the consistence of a Thick Syrup -

Take 2 or 3 Parts of muriate of Lime - add two of Snow at +32 & the solution will be equal to —50° — if that made in winter be used it is only —40° - & when the mixture is again evaporated it yields the muriate of lime equally fit for future experiment ——

Lime in its Reaction for the Muriatic Acid is superior to all fixed alkalies but with this disengages either of them under certain circumstances & this according to M. Berthollet depends on the attraction by a superiority in both concurring the Chemical Attraction — Lime has a Stronger Attraction for this Acid than Ammonia — 24th add lime to Muriate of Ammonia - & Ammoniacal Gas is disengaged & is proved by the odour and by the white fumes formed when Muriatic Acid is brought in contact

It is thus we Hand of Ammoniacal Gas - by mixing equal parts of slaked lime and Muriat of Ammonia (applying a little Degree of heat if best is required) and collecting the Gas over Mercury which Gas is the pure Ammonia ——

(a) The Carbonate of Ammonia instantly decomposes the muriate of Lime and a Carbonate of Lime is precipitated &c. — The reverse of this we should not expect nor does it take place at an ordinary Temp. Carb. of Lime

The process for obtaining this (blended with water) wch is described in the Ph. Ed. is Take 16 oz of Muriat of Ammonia 24 oz of Quicklime 16 oz of Water Pour 12 oz of the Water into an earthen jug add the lime let it stand 24 hours — Add the Mur. Ammon to the rest of the water — having adjusted a receiver to the alembic accurately fitted and secured by a luting of Putty agitate & distil into a refrigerated receiver with a very gentle heat — on a sand bath till 32 oz are drawn over — if the heat be not very gentle the vessel will certainly burst as the Ammonia will be disengaged in its gaseous form — The mode suggested by Woulfe is much safer and none of the product is lost — by employing several tubulated receivers with tubes of Communication ~~&c~~

(a) ~~Hydrocarbonate of Lime Ammonia has very different effects for a double elective attraction decomposition takes place when this and the muriate of Lime if effected with a high temperature~~.

~~[illegible]~~ If muriate of Ammonia be mixed with the ~~[illegible]~~ Carbonate of lime — & a high temp be applied a double decomposition takes place the muriat of Lime is left and a Carbonate of Ammonia passes over — This is very different from what we

might expect — but the reason is this — There is an Attraction between the Ammoniac and the Muriatic Acid — and between the Lime and the Carbonic Acid in the first of these experiments & these are called the Elective Attractions — There is also an Attraction between the — Ammon: & the Carb: Acid & between the Lime & Muriatic Acid — These are the Quiescent Attractions — But the Elective Attractions being stronger than the Quiescent a double decomposition takes place — by which we obtain Muriate of Ammon: and Carbonate of Lime

In the 2d of these experiments the very reverse of this takes place — for on mixing these products — they do not decompose each other in the cold — as we might naturally infer but on applying a artificial heat the decomposition again takes place and we obtain Carb: of Ammon: & Muriate of Lime — & thus the Carbonat of Ammonia is directed to be prepared in the London and Edin Pharmacopoea

Take Muri of Ammon: 1 Part 2 of Carbonat of Lime both ordered to Powder and dried Put them into a retort apply a receiver and lute the junctures by a luting of Chalk and G. Arabic — Place them in a Sand bath & gradually increase the heat but

of this exceed incandescence the Retort wd be melted — we obtain ye Carbonat of Ammonia & ye Muriat of Lime being left in the Retort — Thus in a high Temp Carbonat of Lime decomposes the Muriate of Ammonia — but in a moderate temp the Carbonat of Ammonia decomposes the Muriate of Lime

— The Muriat of Lime exists in some springs and in Sea water — Generally it is procured by dissolving pure Carb of lime in Muriatic Acid — It is used to procure cold — to absorb ye humidity from ye Air and to dephlegmate alkohol

It has been strongly recommended by Dr Beddoes in Scrophulous Complaints and promises to be a medicine of some activity ʒiiss of a solution of it having killed a young dog — it is made by dissolving Marble in Muriatic Acid evaporating to dryness — and dissolving the residuum to saturation in water

— If a ~~stream of~~ stream of oxygenated Muriatic Acid Gas be made to pass thro lime water it is found to form a fluid very powerful in bleaching — Some Gentlemen of Glasgow found that this wd be rendered much stronger by using lime water in which a quantity of lime is suspended

and kept agitated by ~~a~~ a mechanical Contrivance, and of lime so diffused becomes soluble when oxygenated for purposes then the liquor

A Patent has lately been procured for a process of forming the oxymuriate of lime, by putting into a barrel lime slaked & sifted & directing near the top of the Barrel a Stream of oxymuriatic Acid Gas — 2d is absorbed — The Barrel being kept constantly agitated by a mechanical contrivance an oxymuriate of lime is thus prepared easily managed to a distance very soluble in water and almost instantly used in bleaching with great effect

It appears that Lime may unite with 2 oxymuriatic Acid so as to form an hyperoxygenated muriate of lime, but that this has much less of the bleaching power (a)

Phosphate of Lime The Phosphoric Acid readily combines when liquid with lime & forms a compound of very little solubility but by an excess of Acid a salt is formed abundantly soluble &c

The first compound is a neutral the 2d an acidulous Phosphate of Lime — The first forms an insipid bone ash matter — we may procure the acidulous Phosphate of lime in minute Crystals —

It was discovered by Scheele that the Earth of bones was chiefly Phosphate of Lime mixed however with a large quantity of glutinous and oily matter & much Carbonate of Lime

The Phosphate of Lime is tasteless, and inert with regard to the animal Economy

It resists the most intense heat and the fluxing effect of the oxyd of Lead

It is insoluble in water — It precipitates when treating with oxyles and inflammable substances

It is decomposed by Acids and thus we obtain the Phosphoric Acid in the formation of the Phosphat of Soda — See the Formula Pharm. Edin.

The effervescence on adding the Sulphuric Acid arises from the Carbonat of Lime — The filtred liquor contains the Phosphoric Acid sufficiently pure for making the Phosphat of Soda but not for the Chemical Purposes being contaminated with Phosphat of Lime & Sulphat of Lime — to get it if then evaporate to dryness — and by adding a small quantity of water redissolve the Phosphoric Acid or what is better add Aq. Ammonia till the Phosphoric Acid is saturated and filtrate the

liquor then place it in a crucible & apply a requisite heat till the Phosphoric Acid is left in the form of Glass

It is partly decomposed by Vitriolic & Muriatic Acid — wh. is considered as a collateral Evidence of the truth of Berthollet's Doctrine, the Quantity so dissolved amounts according to Vauquelin to 1/3d

The Tartarous Acid has a Stronger Attraction for lime than the Sulphuric Acid

None of the pure Alkalies will decompose this Salt but the Carbonates of the Alkalies have a powerful Effect & actually effect the decomposition, on the other hand lime decomposes the Phosphates of the Alkalies as we might a priori expect Exp.

Dissolve Phosphate of Soda add lime water a muddiness appears caused by the separation of the insoluble Phosphate of lime

— The Phosphate of Lime has been called the animal earth and it was supposed to be so exclusively but it has been discovered in Spain in the Kingdom of Estremadura by Mr Bowles — and Mr Proust has found that it composed entire mountains in Truxillo in Spain. It is the Phosphorite of

Kirwan   Its specific grav: is 2.8. — When heated it exhibits a superb green light In Bohemia Saxony & Cornwall — the Apatites we find the Phosphate of lime in Crystals of six sides and of different Colours — especially yellow blue or green — Its Sp. grav: is 3.21 to water as 1, The Crysolite at least one kind of Crysolite is a Phosphate of Lime the other sp: is a siliceous fossil.

The Phosphate of Lime is used to form vessels for fusing Gold & Silver — to polish metals precious and artificial stones to remove greasy spots from linen & woollen Clothes & Paper —

— **Tartrite of Lime.** is a Compound of little solubility. The Lime has a stronger attraction for tartareous Acid than the Alkalies and therefore when pure it will decompose the Tartrite of an Alkali, and consequently if in procuring the acid of Tartar from the acid: Tartrite of Potash you add pure lime instead of the carbonate you obtain the whole of the Tartarous Acid in Combination

— It was first called the tartareous selenite

— **Acetite of Lime** is a soluble Salt of no use

Borate of Lime is a curious fossil but as
& Magnesia predominate in it it will come
more properly to be spoken of hereafter

Fluate of Lime — The Fluor — Fluor
Spar or Flus of the Germans — This is found
to be a remarkable Combination of & Fluoric Acid
with Lime — This Acid is only found in this
combination excepting in a very small proportion
with Clay — Mr Scheele discovered this in 1771
and called it & Fluor or Spathy acid — It is now
denominated & Fluoric Acid

The ~~Fluate~~ Fluate of Lime is a natural and is
pure Combination & copious production — It is invariably
~~commonly~~ met with in Veins rarely met with
among metallic strata — In the calcareous
strata in Derbyshire a Vein is filled with this
stone which the miners call blue John or blue
Jack — It is sometimes colorless — Its most
com colors are light or dark green — blue
purple yellowish — This sometimes nearly
solid mine rarely of a vitreous texture —
in these instances it is columnar foliated in
radiations often divided by concentric Circles —
— At the surface it often shoots into beautiful

Sol but it depends in some degree on the Colour of the Sheet

crystals and sometimes nearly transparent —

— This Substance is brought by ye Vulcanists as a proof of their theory — for all Crystallized bodies must have been dissolved & in order to admit of that motion of the Particles necessary to Crystallization — it is insoluble in water — therefore they infer it must have been rendered fluid by fire

— It is fusible in the fire. it is hard but not so hard as to strike fire with steel — It bears a high Polish and has been called ye Mock Gem — mock Amethyst — It is employed to form various toys ornaments &c.: Its Sp. Gr: is from 3. to 3,2 compared to water as 1. —

When heat is applied it ~~becomes~~ decrepitates and if ye temp is increased it becomes luminous or Phosphorescent (Expt. The light is a purplish green(a). It will not exhibit this Phenomenon a 2d time having lost ye certain somet. wh. caused the Phosphorescence and of wh. we are ignorant

It melts in a crucible & attacks ye crucible itself and is greatly prized for this quality of a flux

— It is insoluble in water — has no action with ex- acid or alkalies: but a remarkable one with some of the acids Expt Take of Sulphuric Acid —

powdered Fluate of Lime are ℥j – heat them in a retort to wh a receiver is adjusted containing water – There is an Effervescence with heat & an elastic vapor arises – colourless and of a penetrating odour resembling that of Muriatic Acid. A crust is formed on the water – this must be broken by agitation that ye Gas may come in contact with the rest of the water and at length a considerable quantity of the crust is obtained – This by Mr Scheele was ~~thought~~ at first found to arise from the Glass of ye Retort which is actually attacked and corroded – the siliceous earth passing over in ye gaseous elastic fluid & is absorbed by ye water. That this is really ye case may be proved by continuing the operation till ye retort is perforated by ye Corrosive Specimen – or by carrying on a similar Process in leaden Vessels – first without any admixture & ~~then~~ then with an admixture of powdered Glass. The strongest Vitriolic Acid must be used

– From these Circumstances it becomes very difficult to procure the fluoric Acid pure – the best mode is to pick out ye purest fluates of Lime and to decompose them in retorts of lead – keeping the Acid in Vessels of ye same metal or in glass when perfectly coated with wax. ye Spec. of a vial wh D. B. had waxed perfectly as he imagined

but the acid had corroded the lead and escaped -

If the to the Fluoric acid you suspend in glass vessels you add Soda a Potash a triple Comp? is formed of Silex. Potash Soda & Fluoric acid - but if Ammonia be added the silex is precipitated and thus the pure Fluoric acid is obtained

Introduce into a retort equal Wt. of Sil. Fluoric acid and Muriat of Ammonia and receive the Fluoric acid in distilled water placed in a receiver

Muriat of Lime is insoluble in water but in muriatic Muriat of lime is abundantly soluble

Lime has a strong Affection for this acid than the fixed Alkalies - but Carbonates of the alkalies produce a double decomposition

~~Fluoric~~ The Fluoric Acid is supposed to consist of an inflammable radical united to oxygen but experiments has not yet ascertained these respects

This acid is used to corrode glass and to etch upon it in some way as is done by aquafortis on Copper - Cover your plate of Glass with a coat of wax Etc - draw with an instrument as figure you wish for - Pour on it Fluoric Acid - let it remain 12. 24 a 36 hours - then remove the wax this mode was practised and then Fluoric acid must

have been known before Mr Scheele's discovery & and a paper was published containing this mode of Etching on Glass in 1725 at Dresden. and so early as 1670 an artist at Nuremberg was acquainted with it tho he kept it a secret — Vid Nicholsons Journal

An easy mode is to place the glass Plate properly coated and etched over ye vapor arising from a mixture of strong Sulphuric Acid & fluate of lime — It may be done with a better effect in relievo by drawing the figure in wax and corroding the rest of the Plate

These Plates may be used for the same purpose as copper plate etchings but that they may bear ye roller it is necessary to enclose them in a wooden frame at ye bottom of wh there is a depression corresponding to the Plate wh must be filled up with Plaister of Paris or melted Pitch and the Plate adjusted under it — It is used by Glass makers for ornamenting various articles and with good effect and to graduate Thermometers Measures &c &c but the lines are very smooth and therefore not quite so visible as cd be wished

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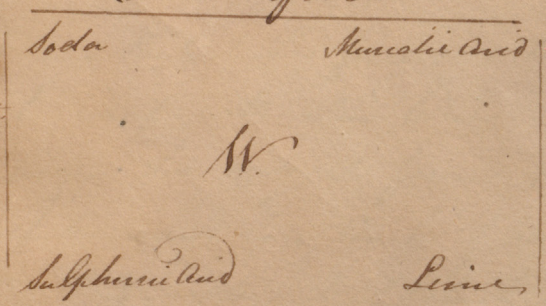
they are left to harden when it and it is applied in the state of paper

The Muriate of Lime is used as a flux in Metallurgy

The order of the Affinities of Lime according to Bobs of Dr Ransen is as follows Sulphuric and Carbonous phosphoric Fluoric Nitric Muriatic Acetous Boracic Carbonic

If we mix with Sulphate of Soda Muriate of Lime a double decomposition takes place

Muriate of Soda



Sulphate of Lime

In N. in this Diagram signifies affinity made and decomposition produced in water at descending point of the inferior bracket denotes precipitation of the Sulphate of Lime and suspension lime being small shews that the Muriate of Soda is held in Solution and it pierces with a Point in the middle. this points to have shewn that the

substance flies off in the form of Gas

For all the acids Lime has a stronger attraction than Ammonia – and a stronger in the fixed alkalies for Phosph: Fort. Boracic & Carb: – If Sulphuric Acid be added to a Solution of muriate of Lime – a Sulphate of Lime is formed & is suddenly absorbing a large quantity of water of Crystalization: Lavoisier a dry mass – Berthollet who is a most Philosophic Chemist in France tho perhaps not the best practical has asserted that Lime is a Compound – & that it also forms certain important Comp: with these bodies – united to Hydrogen he says it forms Potash – & Sulphur says is a Carb: of Magnesia & Arote – If Sulphuret of Potash charged with a strong heat Lime is produced – If oxygenated muriate of Potash is decomposed by heating it with charcoal Carbonate of Potash Lime and Magnesia are obtained – but in opposition to these Schemata of Berthollet it has been found by Vauquelain & D Arak that when the Substances are pure there is no earthy re-

Calcium

Lime is used in Medicine to correct and
in the primæ viæ — the Carb: is rarely used
Lime water too is used in a variety of
cases

In Pharmacy it is employed to separate
Carbonic Acid from Alkalies &c

But its most extensive use is as a
Cement for this purpose it should be perfectly
free of Carb: Acid — It has been proposed to
slake it with lime water and — and 4
or 5 times its wt: of Sand should be added —
Dr Higgins has analysed some of the ancient
Cements and says this is their proportion
The induration depends on the lime attract-
ing Carbonic Acid from the atmosphere
Some advise to mix small fragments of
lime with their mortar and to burn this
into the Crevices — Cement or Mortar wh is
used to connect building under the sur-
face of water is mixed with a portion of
burnt clay wh has the effect of speedily
extracting the water from the lime

Lime is also employed very extensive-

by as a manure either in the state of Carbonate or of pure lime but whichever of them be employed it result is ultimately the same as pure lime will soon extract Carb. and from the air. Its utility depends on its acting as a solvent on the animal & vegetable matters contained in the soil. It is of importance to determine the the quantity of Carbonate of Lime in a field or an estate. This is done in two ways or more. The usual mode in the humid way is to add nitric or muriatic Acid & examine the effervescence with the carbonate of Lime but with almost no other substance found in Peats. If then for a quantity of it either of them and be poured on 100 Grains of the earth to be experimented on. and the nitrogen can duly collected the weight lost by the earth will give you the quantity and the proportion of Carbonate of Lime existing in it.

Another mode of doing this is to expel all the Carbonic Acid from a determinate quant

by ye application of heat and then weighing the residuum — and for every 40 grains lost you estimate ye existence of 100 of Carb: of Lime before ye expt.

— But from some expts of Tennant it appears that this mode is insufficient for ye Carb: of magnesia is prejudicial to vegetation is often intermixed with ye Carbonate of Lime and will present the Phenomena now enumerated. the mode of distinguishd them will be pointed out hereafter when we come to treat of magnesia —

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Really x+780 pages,
for pp. 97, 227, 241 & 553 = 3 pp. each.